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UDC 621.391

Estimation of Signal Delay in Case of Modulating Interference With Unknown Parameters

18600052c Kiev IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 1, Jan 88 (manuscript received
30 Jun 86) pp 24-28

[Article by A. P. Trifonov and A. V. Zakharov]

[Abstract] Reception of a pulse signal mixed with Gaussian white background noise having a unilateral spectral density N_0 and distorted by parasitic modulating Gaussian interference is considered, assuming that the pulse duration is much longer than the interference correlation time and that the interference is a stationary random process with unknown parameters. An estimate of the signal delay under these conditions is arrived at and its accuracy is improved by simultaneous estimation of the interference parameters. Such a quasi-optimum estimate is compared with the maximum-likelihood estimate with known interference parameters. The dispersions of both estimates are compared, each estimate having a high a posteriori accuracy when the signal-to-noise ratio at the output of the measuring instrument is much larger than 1. References: 3 Russian.

UDC 621.391:681.84

Numerical Method of Correcting Image Contrast

18600071a Novosibirsk AVTOMETRIYA in Russian
No 1, Jan 88 (manuscript received 3 Jun 85) pp 54-59

[Article by V. V. Pospelov, Moscow]

[Abstract] A numerical method of correcting the image contrast is validated theoretically, the main problem being not evaluation of the luminance transfer function but its definition which will ensure a better contrast after processing. The necessary and sufficient conditions for existence of a monotonic transfer function which will transform any arbitrary image luminance distribution into the desired one are established in the form of a fundamental theorem, the latter being proved with the aid of six lemmas, and its probabilistic version implying simulation of a random process. A second theorem established the condition for relatedness of an image to its transform and a third theorem establishes the relation between an image and its luminance distribution as an equality of two integrals. The algorithm of such a numerical correction has been programmed and applied to images consisting of 660x840 elements with 250 luminance gradations. Figures 7; references 6: 5 Russian, 1 Western (in Russian translation).

UDC 621.391:681.84

Method of Reconstructing Lost Signal Segments

18600071b Novosibirsk AVTOMETRIYA in Russian
No 1, Jan 88 (manuscript received 20 Jan 87) pp 60-64

[Article by V. A. Pospelov and A. V. Chichagov, Moscow]

[Abstract] A method of reconstructing signal fragments undetectable in some locations at some instants of time is proposed which is much more efficient than polynomial approximation of a signal quantized in time and expandable into a finite Fourier series with a resulting lacunal spectrum, especially when the number of harmonics is much smaller than the number of available signal samples and polynomial approximation requires pseudoinversion of a high-order degenerate matrix. The method involves approximation of the signal within a not necessarily connected subset of an interval, using the characteristic function of the set, with the aid of fast Fourier transformation. It is demonstrated on optimal reconstruction of one harmonic according to the criterion of minimum mean-square error. Extraction of harmonics becomes an iterative procedure. It has been applied to reconstruction of an acoustic signal at the site of a pulse interference which cancels some signal segments. Figures 2; references 7: 4 Russian, 3 Western (in Russian translation).

UDC 621.378

Optimization of Signal From Quadriquadral Position-Sensing Photodetector

18600071c Novosibirsk AVTOMETRIYA in Russian
No 1, Jan 88 (manuscript received 17 Feb 86) pp 83-85

[Article by I. I. Sukharov and S. V. Yakushkin, Novosibirsk]

[Abstract] A symmetric quadral position-sensing photodetector with a cruciform slot splitting it into four square quadral segments and with four differentially connected diodes, one in each quadrant, is considered for measuring the space coordinates of a light beam. The photodetector signal is proportional to the displacement of the light spot center seen through the slot, as long as the displacement remains small. The differential slope of the photodetector signal, which characterizes the photodetector sensitivity, depends on the photodetector geometry. This dependence is analyzed, assuming a Gaussian coherent light beam. For the purpose of photodetector design and signal optimization, this dependence has been evaluated graphonumerically in terms of three relations. The first one is the dependence of the differential signal slope on the ratio of photodetector dimension (side of square quadral segment) to effective light beam radius (from point of maximum intensity at center to circle of e times lower intensity), at various ratios of segment side to slot width. The other two are the dependence of the differential signal slope and of the

optimum segment side to beam radius ratio on the segment side to slot width ratio. The authors thank Yu. V. Troitskiy for helpful discussion. Figures 3; references 3; all Russian.

UDC 621.391:53.08

Digital Algorithm for Reconstruction of Spatially Bounded Signal After Its Convolution With Unknown Distorting Function

18600071d Novosibirsk AVTOMETRIYA in Russian
No 1, Jan 88 (manuscript received 21 Apr 86)
pp 101-103

[Article by V. P. Bakalov, Yu. Yu. Martyushev, and N. P. Russkikh, Moscow]

[Abstract] A digital algorithm for reconstruction of a spatially bounded signal distorted by convolution with an unknown function is shown, namely z-transformation of both signal function and distorting function followed by testing the zeros of both transform polynomials. The sufficient condition for solvability of the convolution equation with an unknown kernel, and thus of the reconstruction problem, is nonfactorability of the two polynomials or a rigid functional relation between their zeros. The problem then reduces to one of linear algebra, which can be solved by numerical methods programmable on a computer. The algorithm is demonstrated on a discrete convolution. Figures 3; references: 3 Russian.

UDC 621.396.629:621.374(045)

Method of Increasing Bandwidth of High-Frequency Photodetector

18600071e Novosibirsk AVTOMETRIYA in Russian
No 1, Jan 88 (manuscript received 1 Apr 87) pp 107-108

[Article by V. A. Zhmud, Yu. P. Kononenko, and A. A. Stolpovskiy, Novosibirsk]

[Abstract] A photodetector consisting of an avalanche photodiode as current generator and an operational amplifier as current-to-voltage converter has been modified for higher sensitivity as well as higher response speed and consequently higher signal-to-noise ratio. It includes, in addition, a cathode follower which compensates the effect of stray capacitance by ensuring a constant potential difference between cathode and anode of the photodiode. This modification, with a stray capacitance lower than 20 pF, has increased the bandwidth by a factor of 10 without sacrifice of gain. The current sensitivity within the 500 kHz frequency band is 10^{-9} A at a 1:1 signal-to-noise ratio. For operation with an acoustooptic cell, which requires a narrow-band high-frequency optical signal, a transformer with a compensating capacitor across the high-voltage primary winding and tunable to the frequency of the acoustic signal is inserted before the photodetector output stage consisting

of a common-base transistor amplifier with a high-resistance load behind the low-voltage secondary transformer winding. Figures 3; references: 1 Russian.

UDC 621.375.54.061

Theory of Optimal M-ary Interperiodic Processing for Detection of Fluctuating Signals in Mixture With Noise and Correlated Interference

18600097a Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
after revision 26 Jan 87) pp 4-8

[Article by V. S. Golikov]

[Abstract] Detection of normally fluctuating and randomly arriving useful signals in an additive mixture with stationary correlated interference signals and white noise by an M-ary blockwise processing system is tested for efficiency. An algorithm of interperiodic cyclic processing by such a system is constructed, optimal according to the Neyman-Pearson criterion, its matrix being different than that of optimal simple processing. Its efficiency is lower than that of optimal simple processing in the case of exponentially correlated interference signals but approaches the latter in the case of small interperiodic phase leads. Figures 2; references 6: 5 Russian, 1 Western (in Russian translation).

UDC 53.088.4:532.031.782:681.883

Feasibility of Constructing Pressure-Gradient Detectors With Space-Diverse Hydrophones

18600110g Moscow IZMERITELNAYA TEKHNIKA in
Russian No 3, Mar 88 pp 46-47

[Article by V. A. Gordiyenko, L. N. Zakharov and N. Ya. Naumov]

[Abstract] The feasibility of constructing a pressure-gradient detector with space-diverse standard pressure detectors operating in an aqueous medium rather than with special detectors with common phase center responding only directly to pressure gradient is examined, its sensitivity and resonance characteristics being analyzed with emphasis on the pressure-gradient detection threshold. A hydrophone set with a pair of space-diverse low-frequency piezoceramic sensors operating in this mode are considered, each sensor consisting of a spherical head inside a spherical shell. Mechanical vibrations are calculated including reaction of the acoustic medium. The level of output noise in the form of voltage fluctuations caused independently by dielectric loss during "stall" and by intrinsic thermal vibrations is shown to depend on the design parameters. Hydrophones using sensors made of TsTS-19 ceramic with 70-80 percent of the noise related to dielectric loss are, accordingly, most suitable for detection of strong pressure-gradient signals within a narrow frequency band. Figures 2; references 10: 5 Russian, 5 Western.

UDC 621.397.62

Digital Television Receivers: Problems and Outlook

18600062a Moscow *RADIOTEKHNIKA* in Russian
No 1, Jan 88 (manuscript received, after revision,
24 Apr 87) pp 3-11

[Article by V. N. Vovk, S. V. Novakovskiy, L. A. Stasenko, and B. N. Khokhlov]

[Abstract] Design and application of analog-digital and fully digital color TV sets are overviewed, considering that a prospective TV set must be a multistandard one equipped with automatic tuning and remote control. The structure of a frequency synthesizer using a simple low-cost microcomputer for tuning and channel selection is described, including its programmable-divisor frequency divider and frequency-phase detector. Demodulation of digital PAL and SECAM signals is described, a digital SECAM decoder consisting of a filter for separation of luminance and chrominance signals, a corrector of high-frequency predistortions, a frequency detector, a corrector of low-frequency predistortions with read-only memory, and a horizontal-delay line with direct-access memory. Requirements for conversion from analog to digital signal processing are reviewed, including modified large-scale or very-large-scale circuit integration and digital phase-lock automatic frequency control of the high-frequency clock generator. Basic size and performance estimates are given. Figures 1; references 10: 2 Russian, 1 Czechoslovak, 3 East German, 4 Western.

UDC 621.372.54:621.396.97

Interpolation Errors During Requantization of Digital Radio Broadcast Signals

18600064f Moscow *ELEKTROSVYAZ* in Russian
No 2, Feb 88 (manuscript received 10 Jul 86) pp 47-50

[Article by M. V. Gitlits and S. V. Bobrovnikov]

[Abstract] The interpolation process during quantization frequency conversion necessary for interfacing digital radio broadcast equipment is analyzed for accuracy, which determines the dynamic range of radio broadcast signals. The interpolation filter follows a low-pass filter which limits the spectrum of an input signal so as to

prevent distortion of the output signal and a multiplier which raises the quantization frequency to the lowest common multiple of input and output frequencies by splitting each pair of significant readings with some number of zero readings in between. Interpolation of these zero readings is then followed by sampling of each significant signal reading at the new (output) quantization frequency. The interpolation polynomial must be selected so as to ensure a sufficiently high signal-to-error power ratio. Numerical calculations for the very common case of quantization frequency conversion from 48 kHz to 32 kHz, assuming a 15 kHz upper signal cutoff frequency for an evaluation of the interpolation error only, indicate that a 75 dB signal-to-error power ratio will be adequate for existing conversion equipment and attainable with a 63d-order interpolation filter. Both spectral and correlation characteristics of a sequence of interpolation errors have been calculated by the Blackman method with intermediate determinations of correlation functions. Figures 6; references 9: 8 Russian, 1 Western (in Russian translation).

UDC 621.397.2.037

Tolerance Monitoring of Digital Television Channel

18600070 Moscow *TEKHNIKA KINO I TELEVIDENIYA* in Russian No 3, Mar 88 pp 13-17

[Article by S. S. Kogan and V. N. Sokolov]

[Abstract] Automatic tolerance monitoring of coaxial-cable or fiber-optic digital television channels which transmit programs from field outposts to the studio is described a major problem being signal distortion in the analog-to-digital converter by fluctuation and crackle noise. As test signal for measuring the signal-to-noise ratio is selected one which covers the range from the top of line-sync pulses to the white level rather than from black level to white level, usually a sawtooth or \cos^2 signal. The equipment includes a video-signal encoder, an audio-signal encoder, a test-signal generator, and a digital-signal multiplexer before the sender terminal, a digital-signal demultiplexer, a video-signal decoder, an audio-signal decoder, and a test-signal extractor-analyzer feeding the built-up TV-channel monitor. The test signal injected into lines 22 and 335 of the SECAM system reveals any degradation of the TV signal beyond the acceptable limit. Figures 6; tables 1; references 7: 6 Russian, 1 CCIR.

UDC 537.86:519.2

Obtaining Radio Images of Large Sources of Weak Radiation Emission in Presence of Noise

18600061a Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIK ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 1, Jan 88 (manuscript received
4 Apr 86) pp 10-16

[Article by I. Ya. Kremer and V. I. Kostylev, Voronezh State University]

[Abstract] Radio imaging a large source of random noncoherent radiation emission in the presence of additive relatively high-energy noise based on maximum-likelihood estimates of the space distribution of brightness is quasi-optimized by application of the A. N. Tikhonov regularization method. The quasi-optimum algorithm is analyzed for efficiency, its advantage being that apriori knowing both location and shape of the source is not explicitly required. When both are not known, the algorithm will yield a radio image of the entire scanned region containing the source. Figures 4; references 10: 7 Russian, 3 Western (2 in Russian translation).

UDC 621.391:523.164

Aperture Synthesis of Noncoherent Objects Through Turbulent Atmosphere

18600061b Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIK ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 1, Jan 88 (manuscript received
25 Feb 86) pp 17-24

[Article by V. N. Uvarov, Institute of Radiophysics and Electronics, UkSSR Academy of Sciences]

[Abstract] A modification of the Rogstad-Rhodes-Goodman method of imaging noncoherent objects such as celestial bodies through the turbulent terrestrial atmosphere by synthesis of nonredundant apertures and postregistration reconstruction of the phase structure of the undistorted image is proposed, similarly on the basis of Jenison relations for "closed phases" and a uniform coherence function for the quiescent field. The conditions for nonredundance and the conditions for matching must be satisfied. Use of a single coded aperture for constructing an array of partial images is involved, which requires separation of the partial images formed by nonredundant apertures in the analyzer. This can be done with a full-aperture reflecting or refracting telescope, preferably with a periscope of the Michelson stellar interferometer type featuring a high resolving power aided by small-aperture telescopes, or with a dispersing device aided by an eyepiece camera. Postregistration processing consists of Fourier transformation with extraction of the phase structure, formulation and solution of a system of equations for the quiescent phases, this step being the most difficult one and followed by formation of the phase structure of the Fourier transform of the undistorted image, then formation of its

amplitude structure, and finally inverse Fourier transformation for reconstruction of the image. The method is shown to feature a higher signal-to-noise ratio than the method of speckle interferometry when the space frequency is high. It requires only one exposure, even without apriori information about and constraints on size of the object. A numerical simulation experiment, with the object subdivided into 64x64 elements and the analyzer containing 8x8 subapertures has yielded excellent results. Figures 5; references 9: 4 Russian, 5 Western.

UDC 533.951

Surface Electromagnetic Waves at Boundary Between Metal and Isotropic Plasma With Nonhomogeneous Resonant Boundary Layer

18600061c Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIK ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 1, Jan 88 (manuscript received
17 Jan 86) pp 25-28

[Article by M. I. Bakunov, Gorkiy State University]

[Abstract] The possibility of surface electromagnetic waves propagating along the boundary between a metal wall and an isotropic plasma is demonstrated, the necessary condition being existence of a nonhomogeneous plasma boundary layer which contains a resonance peak or plateau of plasma concentration. This conclusion is based on an analysis of the solution to the corresponding system of field and wave equations for a TM-mode, assuming an ideally conducting metal and a plasma which is homogeneous except within its boundary layer with a power-law transverse concentration profile symmetric about its median plane. A thin such boundary layer is sufficient for a solution in the form of slowly decaying high-frequency waves. This applies to a weakly collisional and thus cold plasma as well as to a hot plasma with a high collision frequency. Figures 1; references: 9 Russian.

UDC 537.525:621.396.674

Performance Characteristics of Spherical Antenna in Presence of Steady Microwave Discharge

18600061d Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIK ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 1, Jan 88 (manuscript received,
after revision, 15 Jan 87) pp 123-124

[Article by Kh. V. Valiyev, Ye. M. Gandyl, Ye. N. Motorin, B. A. Prigoda, and M. V. Tokarev, Tashkent State University]

[Abstract] The performance characteristics of a spherical radiator antenna energized from a voltage supply through a rectangular equatorial slot are calculated, taking into account that ionization of the ambient gas

after a microwave breakdown limits the antenna radiation power while the degree of ionization increases fast with increasing electromagnetic field intensity and thus with increasing antenna input power. The electromagnetic properties of the ambient gas are described by a complex dielectric permittivity which depends on the plasma frequency and the electron concentration as well as on the frequency of electron-electron collisions. Assuming a quasi-neutral gas, its ionized state in terms of electron concentration satisfies the corresponding equation of continuity with complete recombination at the spherical surface as boundary condition. Assuming an electromagnetic field harmonically alternating in time, the corresponding system of Maxwell equations is reduced to one equation for the azimuthal magnetic field component. Solution of both equations, the equation of continuity by the Galerkin method, for a spherical antenna 100 cm in diameter operating at a frequency of 300 MHz in a gaseous medium under a pressure of 1 torr has yielded one quadrant of the radiation pattern as well as the dependence of the maximum radiation power density and of the maximum plasma electron concentration on the applied voltage. The maximum power density peaks at a voltage approaching the breakdown level and then decreases while the electron concentration builds up monotonically as the voltage is further increased. Figures 2; references: 4 Russian.

UDC 621.396.677

Exciter for Surface-Wave Transmission Line
18600062b Moscow *RADIOTEKHNIKA* in Russian
No 1, Jan 88 (manuscript received, after revision,
9 Feb 87) pp 56-58

[Article by O. N. Tereshin, V. D. Dvurechenskiy, and A. S. Kuskov]

[Abstract] An exciter for surface-wave transmission lines is synthesized with a sufficiently large width-to-length ratio to ensure a uniform transverse electromagnetic field distribution and thus a high excitation efficiency at a low retardation relative to the wave number in the ambient medium. The synthesis is based on the corresponding system of field equations for a semitransparent impedance structure above a metal shield, the electromagnetic field in all three regions consisting of three components: longitudinal electric, normal electric, transverse magnetic. The admittances of reactive loads on both sides of the periodically costate semitransparent structure are calculated in terms of these field components, considering that the latter within this region must satisfy the condition of continuity for the normal component of the Poynting vector. Numerical design and performance calculations indicate that an 85 percent exciter efficiency is feasible. Figures 2; references: 4 Russian.

UDC 621.396.962.001

Method of Synthesizing Wide Impedance-Type Scatterers

18600062c Moscow *RADIOTEKHNIKA* in Russian
No 1, Jan 88 (manuscript received, after revision,
6 Apr 87) pp 58-60

[Article by G. A. Yerokhin and V. V. Shkvarin]

[Abstract] A geometrical optics method of synthesizing an impedance-type scatterer with large cross-section of arbitrary shape is proposed, using as reference reflector a metal strip of uniform width equal to that of the prospective scatter at midspan. The method is demonstrated on a cylindrical scatterer with a piecewise-differentiable cross-section contour in an axial magnetic field. The vector field problem is reduced to a scalar one and its solution in geometrical optics approximation is shown to yield the design of a scatterer with performance characteristics identical to those of the reference reflector. Real limits on the impedance ideally infinite at certain point do not significantly influence the inverse section and the shape of the radiation pattern. Figures 3; references 6: 5 Russian, 1 Western (in Russian translation).

UDC 621.396.67

Use of Fast Fourier Transformation for Calculating Radiation Pattern of Nonequidistant Antenna Arrays

Moscow *RADIOTEKHNIKA* in Russian No 1, Jan 88
(manuscript received 4 Feb 87) pp 66-70

[Article by L. A. Dozorets]

[Abstract] A procedure for calculating the radiation pattern of a nonequidistant multielement antenna array is outlined, its gist being approximation of such an array with an equivalent equidistant one whose total radiation pattern is the same within prescribed accuracy and use of a filtering function which after a fast Fourier transformation will make the sum of a finite trigonometric series uniformly converge into a single square pulse. The effectiveness of this procedure is confirmed by an error analysis and the results of a numerical experiment. Figures 3; tables 1; references 4: 2 Russian, 2 Western (in Russian translation).

UDC 621.396.67

Spectral-Iteration Method of Solving Integral Equations for Thin-Wire Antennas

18600066d Kiev *IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA*
in Russian Vol 31 No 2, Feb 88 (manuscript received
after revision 4 Oct 86) pp 69-71

[Article by N. A. Volynets and V. I. Demidchuk]

[Abstract] The integral equations for thin wires radiating and scattering electromagnetic waves, these equations being reducible to Fredholm integral equations of the

first kind, are shown to be much more economically solvable upon their Fourier transformation into the spectral domain than by conventional matrix methods. The algorithm of fast Fourier transformation further economizes computer memory and time, stability of the solution being ensured by regularization according to the Tikhonov method. This is demonstrated by numerical experiments pertaining to electrically long dipole and helical antenna arrays. Figures 1; references 5: 2 Russian, 3 Western (1 in Russian translation).

UDC (537.874.34+537.876.23):551.510.535

Possibility of Anomalous Mode in Propagation of Short Radio Waves Through Low-Latitude Ionosphere

18600094a Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 3, Mar 88 (manuscript received
31 Mar 86) pp 257-262

[Article by O. B. Veitsman, O. P. Kolomiitsev, and Yu. N. Cherkashin, Institute of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, USSR Academy of Sciences]

[Abstract] Propagation of short radio waves through the low-latitude ionosphere along transequatorial routes is analyzed for the possibility of an anomalous mode. The mechanism of their propagation is described by the ray model, according to which horizontal projections of rays in the electric field with given electron concentration profiles can be calculated by numerical integration of the corresponding ray equations. Such calculations were made for 9-10 MHz radio waves propagating in the meridional plane at the 285 deg geomagnetic longitude during the autumnal equinox, at 15:00 Local Time, with $F_{10.7}$ equal 116 and A_p equal 6. They have yielded an anomalous family of trajectories between crests of the equatorial anomaly and within the 6-10.5 MHz frequency band as the elevation angle drops to 70-60 deg correspondingly. Estimates of energy losses within the entrapped wave field indicate that they are determined essentially by parameters of both the ionosphere and the ground surface. The azimuth angles confining this anomaly can be estimated by this procedure. The authors thank A. V. Popov for helpful comments, also T. Yu. Leshchinskaya and A. V. Mikhaylov for supplying a model of the ionosphere. Figures 3; references 7: 4 Russian, 3 Western.

UDC 538.574.6

Diffraction of Plane Electromagnetic Wave by Dielectric Cone

18600094c Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 3, Mar 88 (manuscript received
11 Apr 86) pp 334-342

[Article by Ye. N. Vasilyev, Z. V. Sedelnikova, and A. R. Seregina, Moscow Institute of Power Engineering]

[Abstract] Diffraction of a plane electromagnetic wave by a dielectric solid of revolution, specifically a conic frustum, is analyzed on the basis of the corresponding integral equation for equivalent surface currents. All electric fields and currents having been expanded into Fourier series with respect to the azimuthal coordinate, this equation is reduced to a system of linear algebraic ones for numerical solution. The distribution of equivalent currents and the scattering pattern as well as the periods of fast beats and the harmonic content in the azimuthal component of the scattered field along with its amplitude have been calculated for frustra with the same radius of the center cross-section and with the same length of the generatrix equal to four wavelengths but with the taper angle varied from 0 (cylinder) to 6 deg and the angle between the direction of wave incidence and the cone axis varied over the 0-180 deg range. They are compared with those obtained by the graphical method. Figures 4; tables 4; references: 4 Russian.

UDC 621.396.67:621.371

Determination of Effect of Ground Surface on Apparent Characteristics of Large Antenna Based on Measurements

18600113a Moscow RADIOTEKHNIKA I
ELEKTRONIKA in Russian Vol 33 No 4, Apr 88
(manuscript received 2 Jul 86) pp 696-699

[Article by E. D. Gazazyan, V. G. Panchenko, and E. S. Tagvoryan]

[Abstract] The effect of the ground surface on the performance characteristics of large antennas is estimated theoretically, with the reflecting ground surface treated as an ensemble of reflecting planes with random unevenness each. The magnitude of the induced surface current is assumed to be the same as in the case of a smooth surface and its phase is assumed to depend on the statistical height distribution of surface asperities. An antenna with circular aperture and rotatable through 360 deg is considered, and the double integral describing its radiation pattern in the vertical plane in an arbitrary position is evaluated on the basis of a plane scalar wave arriving from the source directly as well as after reflection by the ground surface. The stochastic phase error function is regarded as a stationary one with a given correlation radius and a Gaussian distribution. The effect of the ground surface, only a small segment of it reflecting incident waves within a certain range of grazing angles into the antenna aperture, is found to depend largely on the magnitude of the Fresnel reflection coefficient. For experimental purposes are considered the special case of stationary antenna and an RT-18 radio telescope operating in either transmitter or receiver mode. Figures 3; references 4: 3 Russian, 1 Western.

UDC 621.371.34

Study of Radio Wave Reflection by Earth Surface on Basis of Amplitude and Phase Measurements With Two-Position Radar

18600113d Moscow *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 33 No 4, Apr 88 (manuscript received 29 Aug 86) pp 826-833

[Article by V. N. Belan, P. Zh. Kriss, A. I. Kucheryavenkov, A. G. Pavelyev, G. A. Andreyev, and S. A. Ogarev]

[Abstract] Reflection of radio waves by the earth surface was studied experimentally on the basis of amplitude and phase measurements with a two-position radar, hardly any such data having been available so far. The transmitter antenna and both receiver antennas had broad radiation patterns so that the receiver pair picked up signals coming from the transmitter directly and also signals coming from the transmitter indirectly after reflection by the earth surface. The receiver antenna pair constituted a three-base interferometer with orientation in both vertical and horizontal planes, the distance between these two either vertically or horizontally polarized antennas being much smaller than their distance from the transmitter and the latter sending out a circularly polarized signal. That distance from the transmitter antenna to the center point between the two receiver antennas was varied from 50 km to 100 m, while the height of all three antennas above ground was varied over the 30-3000 m range. As the receiver antenna pair was moved relative to the transmitter antenna, it picked up fluctuating signals: the directly arriving signal with regular amplitude and phase fluctuations, the reflected signal with random amplitude and phase fluctuations. The reflection coefficient at the earth surface was calculated from the fluctuating amplitudes of both signals and from their fluctuating phase difference, by application of Parseval's theorem and with the aid of a discrete Fourier transformation. In the experiment were measured the fluctuation spectra of both amplitudes and of the phase difference as well as of the frequency difference in the vertical plane and in the horizontal plane. The reflection coefficient along the trajectory of the mirror point on the earth surface, this point moving along with the receiver antenna pair, was then also calculated on the basis of these spectra and taking into account fadeout during measurements. The range of its oscillations along that trajectory, between 0.02 and 0.25, was found to agree closely with theoretical values based on amplitudes and on phase difference alike. This indicates that only either amplitude or phase measurements alone are sufficient for determining the reflection coefficient. Figures 5; references 6: 3 Russian, 3 Western.

UDC 538.566

Effectiveness of Field Excitation in Atmospheric Surface Waveguide by Ionospheric Sources

18600114a Gorkiy *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA* in Russian Vol 31 No 4, Apr 88 (manuscript received 28 Apr 86) pp 388-393

[Article by S. T. Rybachek]

[Abstract] Excitation of an electromagnetic field in the atmospheric surface waveguide by sources within the most nonhomogeneous and anisotropic lowest layer of the ionosphere is considered, the effectiveness of this excitation being evaluated analytically and then numerically on the basis of the international IRI-78 model of daytime ionosphere with corresponding altitudinal profiles of electron concentration and electron-neutral collision frequency. Ionospheric sources are treated as dipoles and their critical altitude above ground is defined as the lowest one above which they excite an electromagnetic field underneath whose components cease to depend, within a given accuracy, on their orientation. The dependence of the intensity of the radial electric field component on the altitude of ionospheric sources over the 50-150 km range is calculated first for horizontal dipoles, magnetic ones oriented along meridians and electric ones oriented along parallels, then for vertical ones. Horizontal electric dipoles at altitudes higher than critical are found to be more effective than vertical ones at such altitudes. Vertical electric dipoles at altitudes within a certain range lower than critical are found to be more effective than horizontal ones at these altitudes. The effectiveness of dipoles increases as the frequency of field oscillations increases, measurements over the 5-25 kHz range having been made with a receiver on the ground 500 km away from the projection of an ionospheric source onto the ground surface. Figures 5; tables 2; references 8: 6 Russian, 2 Western.

UDC 550.388

Simulation of Nonlinear Interaction of Low-Frequency Electrostatic Waves in F-Region of High-Latitude Ionosphere

18600114b Gorkiy *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA* in Russian Vol 31 No 4, Apr 88 (manuscript received 16 May 86) pp 394-400

[Article by M. G. Gelberg and V. P. Fedorov, Institute of Cosmophysical Research and Aeronomy, Siberian Department, USSR Academy of Sciences, Yakutsk branch]

[Abstract] A mathematical model is constructed for simulating the interaction of low-frequency electrostatic waves in the F-region of the ionosphere during its nonlinear stage of gradient-drift instability, which includes calculating the two-dimensional spectra, in a

horizontal plane, of field intensity and charge density fluctuations in a weakly nonhomogeneous plasma. The corresponding system of 62 partial differential equations for coupled waves is converted into a system of ordinary ones and the latter is solved numerically by the Runge-Kutta-Felberg method with fourth-to-fifth order of precision. As starting data for some solution variants are used nonzero amplitudes and phases of three large-scale modes, for other variants are used nonzero amplitudes only of modes with wave vectors larger than the smallest one and smaller than the largest one. The results of calculations made by this method indicate that the interacting waves do not reach a quasi-steady state when the inertia of moving ions is ignored. With their inertia taken into account, the steady-state plasma turbulence is small and its spectrum is a power-law (approximately square-law) one with respect to k^2 (k -wave number) independent of the initial conditions. Figures 2; references 17: 6 Russian, 11 Western (3 in Russian translation).

UDC 550.388.2

Effect of Geophysical Influencing Factors on Characteristics of Oblique Ionosphere Sounding
18600114c Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
21 Apr 86) pp 401-408

[Article by A. N. Baranets, N. F. Blagoveshchenskaya, T. D. Borisova, and V. A. Budnov]

[Abstract] An experimental study concerning propagation of decametric radio waves through the ionosphere was made by the method of oblique sounding, for the purpose of determining the effect of geophysical factors such as magnetoionospheric perturbations on the results of such a sounding. Measurements were made from the "Soyka" automatic ionospheric sounding station during the November 1981 to August 1982 period, along a 9000 km long path following a parallel within the subauroral zone. Sounding was done with 6-32 MHz radio waves, in 60 24-hour sessions with ionograms plotted once every hour and in 24 additional sessions with ionograms plotted once every minute over a 2-3 h period once a day. The results have been evaluated, using those of vertical sounding as well as ryometer readings for reference. The ionograms have thus yielded information about diurnal variations of usable frequencies as well as median highest and lowest measurable frequencies, also the periods of day or night when they occur in winter and in summer. The ionograms revealed a multimode multipath pattern of radio wave propagation and anomalous absorption of radio waves as a consequence of magnetoionospheric perturbations. The results based on these ionograms are found to agree, on the whole, with results of numerical calculations based on theoretical analysis of such sounding. Figures 2; tables 2; references 14: 12 Russian, 2 Western.

UDC 537.874.6

Diffraction of Electromagnetic Waves by Half-Plane Grid and by Ribbon Consisting of Parallel Conductors
18600114d Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
29 Apr 86) pp 454-464

[Article by V. A. Rozov, Leningrad Polytechnic Institute]

[Abstract] The problem of diffraction of obliquely incident cylindrical electromagnetic waves generated by a current filament is solved for a semiinfinite plane grid and for a ribbon, each consisting of parallel conductors with a radius much smaller than the distance between them and both much smaller than the wavelength. In the case of a semiinfinite grid, the field equation with Kontorovich's average boundary condition is solved by the method of Fourier transformation and subsequent factorization. It is solved for an electric current filament and for a magnetic current filament as source of waves. In the case of a ribbon, the field equation is solved asymptotically according to the geometrical diffraction theory, in the first approximation disregarding secondary diffraction but taking into account the edge effect, for an electric current filament as source of waves. Figures 7; references 9: all Russian.

UDC 621.395.67

Measurement of Reflection Coefficient for Metric Radio Waves at Coatings Absorbing Radio-Frequency Radiation
18600114f Gorkiy IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
22 Jan 87) pp 489-492

[Article by S. A. Pelushenko and M. Ye. Miller, Scientific Research Institute of Radiophysics]

[Abstract] A method of determining the emissivity of "black" disks is proposed, such disks coated with a material which absorbs radio-frequency radiation being used as thermal reference standards for absolute calibration of radio antennas. The disk faces the antenna and receives through it a modulated bias noise signal, some of which it reflects back through the antenna to a radiometer. The reflection coefficient is measured as the ratio of reflected signal to incident signal magnitudes, whereupon it is subtracted from unity to yield the absorption coefficient. Modulation of the bias signal is essential here, inasmuch as it immunizes the radiometer output signal against heat intrinsically emitted by objects in the vicinity of the antenna. The instrumentation for such a measurement includes a modulation radiometer connected to the antenna through a long line and a noise generator (diode with 10^6 K noise temperature) to which a directional coupler is connected. The theory of this bias irradiation method is based on relations for the temperature rise in a disk under these conditions and for the

corresponding increment of radiometer output signal, taking into account the signal-to-noise ratio at the radiometer input. The radiometer is calibrated against a metal disk with unity reflection coefficient, or against a reticular disk designed to have a certain reflection coefficient. The authors thank N. M. Tseytlin for attentiveness, discussion, and helpful comments. Figures 3; references 4: all Russian.

UDC 537.874.4

Polarization Characteristics of Electromagnetic Radiation Multiply Scattered in Cluster of Small Particles

18600114f Gorkiy IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOFIZIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
11 Nov 86, in final version 29 Sep 87) pp 493-495

[Article by V. L. Kuznetsov and V. G. Budanov, Moscow
Institute of Civil Aviation Engineers]

[Abstract] Scattering of electromagnetic radiation in a plane-parallel layer of small anisotropic location-wise noncorrelated particles is considered, the object being to analytically describe the evolution of its polarization characteristics. The need to separate two averaging procedures in the corresponding stochastic wave equation, namely averaging with respect to field parameters and averaging with respect to parameters of the medium, is avoided by extraction of a volume element in the form of a thin layer with particles and by description of scattering in it in the Brownian approximation. A system of equations for the polarization matrices is accordingly derived for such a layer with a given concentration of point scatterers, the latter also absorbing some radiation so that their polarizability tensor is a complex quantity. The boundary conditions on both sides of this layer are stipulated in terms of amplitudes of all incident plane waves, including those which reenter it after having been multiply scattered in it. This system of equations, integrodifferential ones, is reducible to a Fredholm integral matrix equation of the first kind with a degenerate kernel and therefore one which can be solved exactly. The authors thank F. V. Bunkin and Yu. N. Barabanenkov for helpful discussions.

UDC 621.3:087.92.085.414

Selection of Structure and Scale for High-Speed Wideband Analog-to-Digital Converter

18600110a Moscow IZMERITELNAYA TEKHNIKA in Russian No 3, Mar 88 pp 10-11

[Article by B. V. Bardin]

[Abstract] Design of high-speed wideband analog-to-digital converters is analyzed from the standpoint of the quantization error, selection of the appropriate nonuniform quantization scale being the simplest way to ensure maximum data compression and minimum code redundancy. Two quantization characteristics are evaluated, a uniformly logarithmic one and a biased logarithmic one, the parameters of both being referred to those of a uniform characteristic as basis for comparison. Both are found to simplify the converter structure for a wide dynamic range rather than for a high accuracy requirement. A uniform logarithmic scale is, moreover, optimum with respect to minimum relative or mean-square quantization error, the signal-to-noise ratio in this case not depending on the form of the probability density function of the input signal. Figures 2; tables 1; references: 1 Western.

UDC 681.586:681.2

Dynamic Errors of Analog-to-Digital xy-Displacement Converter With Circularly Scanning Light Beam

18600110b Moscow IZMERITELNAYA TEKHNIKA in Russian No 3, Mar 88 pp 21-23

[Article by K. I. Bogatyrenko]

[Abstract] Analog-to-digital xy-displacement converters with a circularly scanning laser beam are considered for various industrial applications, on account of their high accuracy over a wide range of displacements. Analog-to-digital conversion of the angle between the lines from two receivers to the center of the scan circle while the latter moves with the object along a plane trajectory is analyzed for dynamic errors caused by continuous motion rather than discrete displacements of the object. Estimation of these errors on the basis of applicable kinematic relations in the given geometrical configuration and requiring solution of a transcendental equation, with expansion into a fast converging series and therefore only a few iterations, can be done with the absolute error read either from the initial angle or in the physical

sense more meaningfully from the final angle so as to constitute a lag behind that angle at the end of the scan period. The optimum location of the four receivers for determining the coordinates of an object in motion is on the axes of coordinates at equal distances from the origin of coordinates. The dependence of the errors of coordinates determination on the errors of angle measurements, not easily established in explicit form owing to unwieldiness of the converter structure, has been established in implicit form by numerical simulation with linear interpolation for harmonic motion of the object. Figures 2; references: 3 Russian.

UDC 621.317.7(088.8)

Electronic Current Transformers for Superhigh-Voltage Systems

18600121a Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 88 (manuscript received 14 Jul 87) pp 10-15

[Article by K. S. Detlarchyan, F. N. Shakirzyanov and I. K. Gabayeva, Moscow]

[Abstract] Electronic current transformers operating on the basis of ferromagnetic resonance and current-to-frequency conversion are considered for superhigh-voltage systems, their advantages over optoelectronic ones being not only higher accuracy and higher thermal stability but also smaller nonlinearity and smaller variance of dynamic characteristics. The theory of such a device is applied to the design of several variants, the simplest but also least reliable one having the cavity of the microwave oscillator next to the primary current conductor and inductively coupled to the ferromagnetic resonator. The reliability is improved by simplification of the circuitry on the high-voltage side, the latter being rendered passive by a segment of a microwave transmission line running along the primary current conductor and acting as a gyromagnetic filter with the ferromagnetic resonator as well as a bias-magnetizing circuit included. A more elaborate variant has a microwave oscillator with frequency modulation and an automatic control system including a discriminator not for stabilization of the oscillator frequency but for establishing the law of frequency variation in the gyromagnetic filter, the frequency here being linearly dependent on the primary current. The dynamic characteristics of these electronic transformers as well as the errors of automatic frequency control are calculated analytically and evaluated numerically on the basis of the relevant design parameters. Figures 6; references: 11 Russian.

Improving Operation of Telephone Networks
18600063a Moscow VESTNIK SVYAZI in Russian
No 2, Feb 88 pp 19-23

[Article by I. P. Maslenkova]

[Abstract] Equipment has been recently developed and built for improvement of the telephone service, taking into account a projected 40 percent increase of the number of active telephone sets nationwide over the 1985-90 period and aiming at a better overall cost effectiveness. The equipment includes a monitor of transmission quality, a monitor of line multiplexing, and an operations monitor which automates processing of codograms as well as scanning for and location of faults. Components and other details of this hardware are compatible with and adaptable to specific conditions and requirements in regional, district, metropolitan, and local telephone networks. Development of updated second-generation monitoring equipment was begun in 1987, in time for conversion to decade step-by-step automatic exchanges providing 24-h service to begin in 1988. Other improvements include installation of mini-computers facilitating automation and centralization of technological processes, better dialing system, more efficient cash collection from coin booths, and standardization of control equipment components. Exchange offices are being streamlined for on-line real time operation.

UDC 621.396.662.072.6.078

Statistical Dynamics of Search System With Phase-Lock Automatic Frequency Control During Stepwise Frequency Scan
18600065b Moscow RADIOTEKHNIKA in Russian
No 2, Feb 88 (manuscript received after revision 22 Jun 87) pp 27-30

[Article by O. F. Bokk, M. I. Drugov, and A. I. Sergiyenko]

[Abstract] Transients in a search system with phase-lock automatic frequency control and with an optimum correlational signal detector as lock-in indicator are analyzed statistically, such a detector not only minimizing the transients during frequency scan when an input signal with unknown initial appears mixed with additive noise but also reconciles the filter characteristics with dynamic constraints. The search system is assumed to include a proportional-integrating filter with high inertia in the main branch of the automatic control system and the frequency scan is assumed to be a stepwise one. Figures 3; references 8: 6 Russian, 2 Western (in Russian translation).

UDC 621.396.677

Adaptive Spacewise Suppression of Clutter
18600097b Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received after revision 15 Jun 87) pp 15-20

[Article by A. D. Pluzhnikov, A. G. Ryndyk, and S. M. Kashayev]

[Abstract] Processing of signals by a radar in the steady-state mode with adaptive spacewise suppression of clutter is analyzed, considering clutter caused by local objects and a not too distant ground surface. The radiation pattern of an antenna array tracking a target and optimally processing the signals from it in this mode is synthesized, considering that during the time between signal transmission and signal reception the antenna will rotate through an angle proportional to the scan rate as well as to that time lag and thus to the distance from the reflector. Description of the radiation pattern in the form of a polynomial or a rational fraction makes it possible to include a dip in it necessary for a definite angle sector and the algorithm of steepest descent will minimize the mean-square adaptation error. Shortening the scan time by increasing the scan speed, electronically, facilitates interscan data accumulation without the payoff in signal-to-noise ratio being appreciably diminished by attendant widening of the clutter spectrum and consequent worsening of the Doppler selection. Figures 4; references: 6 Russian. E

UDC 621.396

Performance Characteristics of Adaptive Moving-Target Detector With Wobbling Repetition Rate of Probing Pulses
18600097c Kiev IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received after revision 1 Jun 87) pp 20-24

[Article by A. V. Agranovskiy, A. A. Yeliseyev, and A. V. Pokrovskiy]

[Abstract] The performance of an adaptive moving-target detector for air traffic control operating by the method of double interperiodic subtraction is analyzed, with a wobble of the repetition rate of probing pulses taken into account. The dependence of the average subclutter visibility coefficient and thus the detector efficiency on the r.m.s. error in the estimate of the Doppler shift of the center frequency in the energy spectrum of a moving interference is calculated on the basis of the transfer function of the detector, which determines the interference suppression coefficient, for eight forms of interference fluctuations correlation and corresponding spectral density. This dependence is found to be particularly strong in the case of interference spectra with steeply dropping density at the edges such as

a Gaussian one and to become weaker as the energy spectrum of interperiodic fluctuations widens. Figures 1; tables 2; references: 3 Russian.

UDC 621.396.96

Estimation of Interperiodic Signal Phase Shift in Presence of Correlated Interference
18600097d Kiev IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
13 Jul 87) pp 31-37

[Article by P. A. Bakulev and S. V. Guskov]

[Abstract] Digital algorithms of estimating the interperiodic Doppler phase shift in signals arriving together with correlated interference is considered for detection by a radar with unambiguous distance measurement. The bias and the dispersion of such estimates are calculated on the basis of adequate statistics, not explicitly differentiable with respect to the phase shift, for a quasi-deterministic signal with a square envelope of its readings in normally distributed samples of its additive mixture with a correlated interference. Algorithms using "bleached" samples are preferable to tracking algorithms, the latter being designed for large output signal-to-interference power ratios only. Two algorithms with "bleaching" are compared, one for multichannel detection and one for single-channel detection. While the former is shown to yield a more accurate estimate, the latter is simpler and tends to equalize the detection efficiency throughout the radar system. Figures 4; references 9: 8 Russian, 1 Western.

Unambiguous Distance Measurement in Presence of Clutter
18600097e Kiev IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA,
Vol 31 No 4, Apr 88 (manuscript received 5 Nov 86)
pp 37-42

[Article by A. G. Rydnyk, K. P. Polov, and S. A. Puchkov]

[Abstract] Operation of a radar with high pulse repetition rate is considered and phase modulation, not requiring adjustment of the transmitter power level, is proposed as a simple method of avoiding ambiguous distance readings in the presence of clutter, notwithstanding the thus weakened interference suppression and the possibility of inadequate ambiguity removal in the case of overlapping phase-modulated signals. Such an operation is analyzed, assuming random or deterministic modulation of the initial phases in a periodic sequence of radio signals with available means of coherent subsequent signal processing, and using the ratio of successful to total numbers of computer-aided statistical experiments as estimator of the probability of correct measurement. The reliability of distance measurement by the pulse-phase method is then evaluated, assuming that the

aposteriori probabilities of such measurements are determined by the likelihood ratio accurately down to a constant normalizing coefficient in the case of a uniform apriori probability distribution of measured time delays, and this method involving deterministic phase modulation is found to be preferable to random phase modulation. Figures 5; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 621.391.26:621.396.96

Superresolved Detection of Fluctuating Swerling Target Signals
18600097f Kiev IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA
in Russian Vol 31 No 4, Apr 88 (manuscript received
after revision 16 Jun 87) pp 78-80

[Article by A. S. Firsakov, A. V. Nesnov, and S. A. Khranchenko]

[Abstract] Detection of multidimensional fluctuating signals reflected with superresolution by a Swerling target surface is analyzed, such a surface with one major and an array of minor "brilliant points" within a resolution element approximating a real target surface most realistically. This model is an intermediate one between a surface with many equipotent "brilliant points" within a resolution element (reflected signals having random phase and Rayleigh amplitude and a surface with only one "brilliant point" within a resolution element (reflected signals having random phase and nonfluctuating amplitude). The characteristics of a square-law detector for such signals with attendant noise each are calculated, considering the conditional probability density distributions of two independent normal components. The results indicate that target detection with superresolution using multidimensional signals is equivalent to non-superresolved target detection with an approximately 0.5 probability, and that with a higher than 0.7 probability of detection, use of superresolution extends the range. Figures 1; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 621.371.332

Plotting Radar Images of Conducting Objects Probed With Short Pulses
18600109a Moscow RADIOTEKHNIKA in Russian
No 4, Apr 88 (manuscript received, after revision,
21 May 87) pp 3-6

[Article by A. S. Kuznetsov and B. A. Stryukov]

[Abstract] A method of plotting radar images on the basis of experimental data and with the aid of a mini-computer has been developed for implementation, with maximum fidelity, by a wideband radar which operates in the high-frequency scattering range and probes conducting objects with short radio pulses. The pulse generator, a traveling-wave tube triggered by a voltage drop of

subnanosecond duration at the microwave input, is coupled to both transmitter antenna and receiver antenna, the latter being connected to a stroboscopic oscilloscope and a minicomputer. A radio pulse in the 10 cm wave band, 0.5 ns wide at 20 dB level below the peak and carrying a power of 100 W, is repeated at a rate of 0.1 MHz. Such a pulse, upon reflection by a conducting object, consists of a stimulated component and a much smaller intrinsic one so that image of the object can be represented as an array of bright points distributed over some range. Plotting the image subsequently involves, in essence, solving pairs of equations of straight lines whose slopes and intercepts are trigonometric functions (tangents) of the aspects angle. The procedure is demonstrated on such plotting of a metal cone. Figures 8; references 8: 2 Russian, 6 Western.

UDC 631.3.62

Self-Contained Radar Speed Transducer for Surface Vehicles

18600109b Moscow *RADIOTEKHNIKA* in Russian
No 4, Apr 88 pp 31-33

[Article by L. G. Maloratskiy; annotation of article No 1243-sv filed at the Central Scientific-Technical Institute 'Informsvyaz']

[Abstract] The performance characteristics of one-beam and two-beam Doppler radar effective-speed transducers are evaluated analytically for design of such devices in self-contained version for surface traffic control. The error of Doppler frequency measurement having been found to depend on both width and elevation angle of the transmitter-receiver antenna radiation pattern, an experimental evaluation of a prototype operating in the 3 cm wave band (10,525 MHz frequency) with a 1 s integration time indicates the advantage of narrowing the Doppler spectrum by narrowing the radiation pattern and operating with shorter waves in addition to use of the second beam for compensating errors caused by galloping (oscillations of the longitudinal axis). Figures 2; references: 2 Russian.

UDC 621.396.96

Use of Kinematic Indicators for Selecting Spurious Intersections of Bearing Lines in Two-Point Goniometer Systems

18600109c Moscow *RADIOTEKHNIKA* in Russian
No 4, Apr 88 (manuscript received, after revision, 15 Aug 87) pp 38-43

[Article by Yu. G. Bulychev and A. A. Korotun]

[Abstract] A problem in selection of moving targets in a field of at least two by means of two goniometers, namely determination of spurious as well as true intersection points of one target's bearing lines, is solved analytically by using a set of independent kinematic indicators obtainable

from the corresponding equations of kinematics in accordance with the given geometrical configuration. The difference between the ratios of slopes of a target trajectory read by the two goniometers provides a more reliable indicator than the difference between the respective measured angles of that trajectory relative to the base line joining the two goniometers and more reliable than the difference between target travel times from the point of tracking to the respective beam line. This method is applicable to targets moving all along parallel lines, for which case another kinematic indicator involving the number of targets for which the other three indicators become zero is added. Difficulties arise as the field of targets become denser and the measurement errors become larger. An algorithm of selection has been constructed which accounts for the random nature of those three kinematic parameters, assuming normal distributions (with zero mean values but given dispersions) of the errors of differences not only between the two goniometer angle readings but also between their first and second time derivatives. The apparatus implementing this method of selection includes a resolver on the output side which separates spurious intersection points from true ones. Figures 2; references: 7 Russian.

UDC 621.396.67:523.164(024)

Measurements Made by Antenna With Arcuate Collimating Probe

18600109d Moscow *RADIOTEKHNIKA* in Russian
No 4, Apr 88 (manuscript received 11 Jun 87) pp 68-70

[Article by Ye. N. Voronin and Ye. Ye. Nechayev]

[Abstract] An arcuate collimating probe around a measuring antenna in the near field is proposed for ensuring high accuracy in practical cases of not quite closed and continuous surfaces around the antenna, when the absolute accuracy of conventional methods such as that of Huygens-Kirchhoff vector integral equations or use of Green's function or expansion into eigenfunctions of the wave equation is not attainable. The validity of the new method is demonstrated by the expression for the r.m.s. error of the thus reconstructed antenna radiation pattern, the upper bound of this error being inversely proportional to the length of the collimating probe. The proposed average-optimum algorithm of antenna radiation pattern reconstruction with such a probe is simple and applicable to antennas with a diameter smaller than twice the radius of the arc on which the probing half-wavelength dipoles are uniformly spaced and for sine-law excitation by a traveling wave without first-order edge effects. Figures 3; references: 5 Russian.

UDC 621.396.61:621.317.76:65.011.56

Automatic Instrumentation for Determining Momentary Frequency Instability of Signals From Rescue-Service Radiobuoys

18600110d Moscow *IZMERITELNAYA TEKHNICA*
in Russian No 3, Mar 88 pp 24-26

[Article by I. A. Yermolenko, K. P. Pavlov and O. G. Yushkevich]

[Abstract] Instrumentation is described which automatically determines momentary frequency instability of

signals from rescue-service radiobuoys in the global COSPAS-SARSAT communication system operating on the basis of Doppler frequency shifts, the radiobuoys operating at a frequency of 406.025 MHz with radio pulses of 0.44 s duration and 50 s periodicity. The instrument consists of a signal conversion module with two inputs, a 5.0 MHz reference oscillator, a digital time-interval meter, a synchronizer and an interface to an Elektronika D3-28 microcomputer with an alphanumeric printout. Two successive frequency conversions of a radiobuoy signal take place in the input stage with the aid of auxiliary heterodyning 405.0 MHz and 1.0 MHz signals, to a 15-35 kHz second intermediate frequency, the bandwidth of the entire conversion channel being 20 kHz and the duration of transient response to pulse signals not exceeding a fraction of a millisecond here. The second-intermediate signal is boosted by a low-noise amplifier before proceeding to a threshold device, the latter generating pulses which upon frequency step-down by a factor of 25 are used for measuring time intervals. The microcomputer controls measurements through the interface and the synchronizer. The frequency resolution of this instrument is determined by fluctuations in the conversion stage, by instability of the reference oscillator, and by errors of time-interval measurement and thus by the quantization error in the digital time-interval meter. The instrument can be used for determining not only the frequency instability parameters of radio pulse signals but also the phase fluctuation spectra of continuous radio signals. Figures 2; tables 1; references: 6 Russian.

UDC 537.226.2

Comparative Evaluation of Radar and Microwave-Radiometer Methods of Determining Dielectric Permittivity

18600114d Gorkiy IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 4, Apr 88 (manuscript received 14 Jul 86) pp 421-425

[Article by V. P. Yakovlev and I. P. Vuzman, State Scientific Research Center for Study of Natural Resources]

[Abstract] The theory of determining the dielectric permittivity of a medium such as the earth or the ocean on the basis of microwave backscattering measurements is outlined, and analytical expressions are derived which take into account surface roughness. A mildly rough surface is considered so as to simplify the corresponding equations of electrodynamics and their solution by the perturbation method. Two methods of such a measurement, with a radar and with a microwave radiometer, are compared with respect to accuracy and signal-to-noise

ratio. On this basis, measurement with a radar is preferable for relative permittivity lower than 8 and with a radiometer is preferable for relative permittivity higher than 8. Figures 2; references 5: 4 Russian, 1 Western.

UDC 621.396.962:517.217

Digital Methods of Range Finding by Pulsed Scanning Radar

18600122d Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 88 (manuscript received 12 Jan 87) pp 35-40

[Article by Yu. N. Gorbunov, Chelyabinsk]

[Abstract] Digital algorithms of range finding by a pulsed scanning radar are analyzed for accuracy and for optimizability of data processing. The feasibility of simultaneous processing of several read-outs rather than by increasing their word length is considered, randomization being proposed for filtering out discretization errors but correlational rather than random sampling being proposed for minimization of the mean-square error. The recurrent-search method of locating the center of gravity of the echo signal and thus estimating the range is compared with and found to excel several known other methods (Kiefer-Fibonacci golden section or pairwise search, direct count, delayed coincidence), but the algorithms of these other methods being combinable into a general recurrence form as required by the computer and dictated by convenience. Figures 3; references 8: 6 Russian, 2 Western (1 in Russian translation).

UDC 535.2:621.391

Active Synthesis of Wavefront of Object Field With Aid of Luminance Holograms

18600122h Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 88 (manuscript received 23 Sep 85) pp 54-59

[Article by A. V. Anufriyev, A. L. Volpov, Yu. A. Zimin and A. I. Tolmachev, Moscow]

[Abstract] A method of imaging large objects without use of wavefront sensors is proposed, namely by illumination of the object with three coherent light sources closely spaced along two mutually orthogonal axes and recording the luminance hologram. The method offers the advantage of being insensitive to phase distortions caused by the ambient medium during observation of an isoplanate object near the entrance pupil of the optical receiver. Wavefront synthesis by this method is analyzed on the basis of the system geometry and optics, the optical field being treated as one of two coherent point sources in each of the two planes. The error of amplitude determination and the error of phase determination are then calculated analytically, assuming two light sources with equal finite apertures, whereupon they are estimated numerically on the basis of typical system parameters and measurements in a turbulent atmosphere. Figures 1; references 8: 1 Russian, 7 Western (2 in Russian translation).

UDC 621.372.452

Segmentation of Two-Dimensional Television Images of Large Objects Within Frame

18600053d Leningrad IZVESTIYA VYSSHIKH

UCHEBNIKH ZAVEDENIY:

PRIBOROSTROYENIYE in Russian

Vol 31 No 1, Jan 88 (manuscript received 2 Feb 87)

pp 73-77

[Article by K. K. Klechko and A. I. Stepashin, Ryazan Institute of Radio Engineering]

[Abstract] An algorithm of image segmentation within a television frame for digital image processing is proposed, specifically for two-dimensional images of large objects appearing with a composite nonuniform background. It includes line-by-line scanning the image matrix whose elements appear on the screen at discrete instants of time and initially estimating the amplitudes of video signals corresponding to respective image segments, which is done by the method of least squares in accordance with its recurrence scheme, then assigning the boundaries of extracted segments to respective elements of two $N_0 \times N_0$ matrices of coordinates (N_0 - number of geometrical parameters characterizing extracted regions) and combining equivalent regions which have at least one pair of equivalent segments, this involving also an $N_0 \times N_0$ equivalence matrix and an $N_0 \times N_0$ matrix of geometrical parameters. The algorithm four situations: 1) modulus of difference smaller than threshold; 2) modulus of difference equal to or larger than threshold; 3) extracted line segment corresponds to several equivalent segments of preceding line with modulus of difference smaller than threshold, 4) several equivalent segments of given line correspond to one segment of preceding line with given marker so that only the first of those segments receives the same marker and the successive ones receive new markers. The speed of this algorithm depends on the television image. Article was presented by Department of Automation and Telemechanics. References: 6 Russian.

UDC 621.372.8.082.6

Modification of Probe With Thermoluminophor-Coated Transducer for Field Scanning Inside Microwave Channels

18600113e Moscow RADIOTEKHNIKA I

ELEKTRONIKA in Russian Vol 33 No 4, Apr 88

(manuscript received 27 Nov 85, after correction

4 Feb 87) pp 886-888

[Article by V. I. Dobryshevskiy, N. V. Kotosonov, V. N. Mizgaylov, Yu. P. Timofeyev, S. A. Fridman and L. M. Tsivtsivadze]

[Abstract] A probe for scanning the field inside a microwave channel is described which includes a transducer with conventional thermoluminophor coating but multilayer film structure fitting into a given channel. The probe includes also a microwave oscillator, a waveguide

segment, and a matched load. Ultraviolet radiation from a source such as a N_2 -laser is focused by a quartz lens onto the entrance to an optical fiber transmitting it to the multilayer film structure which glows in response. This optical signal is transmitted from the transducer through another fiber to a photodetector which converts it into an electric one. Both fibers, with a quartz core 0.4 mm in diameter each, pass through the microwave channel. The probe was tested in a regular rectangular waveguide and in one containing metal strips. Its sensitivity, depending on the ultraviolet radiation level, is of the order of 10 mW/cm². Its dynamic range is approximately 15 dB and its space resolution of several lines/mm approaches the theoretical one. With a calibrated attenuator in the circuit, the magnitude of the electric signal increases linearly with increasing microwave power within a certain intermediate range of this power prior to peaking. Figures 5; references 5: 4 Russian, 1 Western.

UDC 656.259.12:621.3.025

Radioelectronic Monitor of Vacancy on Switching Tracks in Shunting Yard

18600117a Moscow AVTOMATIKA,

TELEMEKHANIKA I SVYAZ in Russian

No 5, May 88 pp 4-6

[Article by A. A. Semenov, chief designer, All-Union Scientific Research Institute of Railroad Automation]

[Abstract] A radioelectronic microwave monitor of vacancy on switching tracks in a shunting yard has been developed, to replace existing insufficiently reliable photoelectric monitoring devices. This monitor is not only more reliable and weather-proof but also adequate for recording the presence of long-base rolling stock such as 8-axle 120-ton cisterns with smooth chassis completely clearing the space underneath for unhindered passage of a light beam. The monitor has been designed in four variants, for installation in new or old shunting yards respectively. The RTD-S1 set consists of one transmitter and two receivers, all mounted on a common support post. Both RTD-S2 and RTD-S3 sets have only one receiver each, these are for replacement of existing photoelectric monitors. The RTD-S4 set is a reserve item with transmitter and receiver for replacement of those in any of the three other sets during preventive inspection or repair. The components in each set include a GLPD-1 microwave oscillator, two KD412A high-frequency diodes, five AL307BM light-emitting diodes, one KR544UD2A differential amplifier, five discrete K561 microcircuit chips, two KT630B transistors, four forks with OYeTs-RG-09-19/24 rosettes, and two microwave adapters. The four sets are each differently laid out and mounted, to suit their respective operating conditions. Figures 5.

UDC 681.325.5-181.4

**Design Characteristics Required of
Microprocessor Systems for Automation and
Remote Control of Railroad Traffic**

18600117e Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 5, May 88 pp 32-34

[Article by V. V. Sapozhnikov, doctor of technical sciences, professor, Vl. V Sapozhnikov, doctor of technical sciences, professor, and L. I. Borisenko, candidate of technical sciences, docent, Leningrad Institute of Railroad Transportation Engineers]

[Abstract] In connection with the on-going changeover from mechanical relay-contactors to automatic contactless remote control of railroad traffic, the practicality of including microprocessors in the system is examined from the standpoint of the steadily increasing functional and structural complexity of signalization, centralization, and interlocking equipment. The four main advantages of microprocessors for this application are: 1) feasibility of matching hardware and software for any control process, 2) universality and flexibility of microprocessor hardware, which facilitate expanding the scope of automatic control with maximum economy of time and material, 3) excellent manufacturability of microprocessor hardware, 4) availability and low cost. The main three problems in operation of microprocessors are: 1) relatively low speed of sequential execution of programs, 2) difficulties associated with ensuring adequate interference immunity, 3) difficulties associated with maintenance, troubleshooting, and repair. Microprocessors designed for this application must, therefore, be very reliable in terms of traffic safety, and readily serviceable.

UDC 621.3.016.32.313.322:629.12.001.57

**Stability of Parallel Operation of Shipboard
Electric Power Plant and Screw-Driven Electric
Generator**

18600121b Moscow IZVESTIYA AKADEMII NAUK
SSSR: ENERGETIKA I TRANSPORT in Russian
No 2, Mar-Apr 88 (manuscript received 22 Jul 86)
pp 35-41

[Article by Yu. M. Gilerovich, Yu. P. Koskin and N. N. Smirnova, Leningrad]

[Abstract] Continuous parallel operation of an autonomous auxiliary electric power plant and the screw-driven main electric generator on board of a ship is analyzed for stability under perturbations of either screw rotation or in that autonomous power plant, the latter including a steam generator and a steam engine as prime mover. Both electric generators are assumed to be 3-phase synchronous ones and the static resistive-reactive load to constitute 40 percent of their full capacity, the ratio of main drive power to auxiliary drive power being 10:1. The mathematical model of both electric generator in parallel consists of matrix differential equations with variable coefficients describing electrical and mechanical transients in both systems and in the load, these equations being solvable by numerical methods with the aid of a program package developed at the Leningrad Institute of Electrical Engineering. The results of calculations indicate that stability of parallel operation is achievable here when the rotors of the two electric generators have moments of inertia in a 2:1 ratio and the two prime movers have governors with a static stability margin of at least 0.05 during rocking and 0.12 during running through ice. Figures 4; references: 5 Russian.

UDC 621.385.6.01

**Criterion for Collectivity of Processes Involving
Electron Beam in Miniature Vacuum Electron
Devices**

18600113b Moscow *RADIOTEKHNIKA I
ELEKTRONIKA in Russian Vol 33 No 4, Apr 88*
(manuscript received 19 Nov 86) pp 756-761

[Article by Yu. L. Bobrovskiy, S. R. Zarembskiy and V.
V. Starikov]

[Abstract] Considering that space charge appreciably influences processes in microwave vacuum electron-beam devices, especially in miniature ones necessarily operating at high current levels and correspondingly lower voltage, magnitude of the supply voltage has been found to serve as a convenient criterion for their design optimization on the basis of a full three-dimensional model. Accordingly, the limiting voltage across a three-dimensional interelectrode space is established as reference. As criterion indicating the nature of processes within the electron beam is then introduced the "Debye" voltage, this voltage being lower than that limiting one for individual kinematic processes and higher than that limiting one for collective wave processes. Figures 1; references 5: all Russian.

UDC 621.395.345

Functional Components of Subscriber Module in M-400-US Automatic Telephone Exchange

18600117c Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 5, May 88 pp 11-14

[Article by R. S. Ivanov, engineer, and V.P. Tomilov, engineer]

[Abstract] The functional components of a subscriber module in an M-400-US microprocessor-controlled automatic telephone exchange are described, its four components operating in sequence as they process a call. They are, in the order in which they operate: a subscriber set matching the subscriber line through the switchboard with the proper cord sets or connector sets, a subscriber scanner checking the state of subscriber lines, a subscriber tester checking the state of subscriber sets, and a categorizer of subscriber data. Figures 2.

UDC 621.391.268:007.52

Parallel-Sequential Method of Correlation Calculus for Pattern Recognition

18600122b Novosibirsk AVTOMETRIYA in Russian
No 2, Mar-Apr 88 (manuscript received 25 Feb 86)
pp 26-32

[Article by S. M. Borzov, I. S. Gibin, I. I. Razumova and V. N. Khudik, Novosibirsk]

[Abstract] The parallel-sequential method of calculating the correlation functions for optical pattern recognition is analyzed, the advantage of this method over the parallel method being that it allows for flexible formation of reference images with proper scale and orientation in real time. A correlator operation by this method is capable of pattern recognition on the basis of apriori information in the presence of equipment noise. This is demonstrated on calculation of two-dimensional correlation functions. The weight functions necessary for this purpose are optimized by proper selection of storage time and quantization step for the most characteristic segments of reference images so as to maximize the difference between autocorrelation and cross-correlation maxima. This will ensure high reliability of pattern recognition, which has been confirmed on several test patterns. Figures 5; tables 1; references 11: 5 Russian, 6 Western (1 in Russian translation).

UDC 535.317.1

Resolution Attainable in Reconstruction of Tomographic Image by Method of Expansion Into Orthogonal Series

18600122c Novosibirsk AVTOMETRIYA in Russian
No 2, Mar-Apr 88 (manuscript received 1 Jun 87)
pp 32-35

[Article by I. N. Troitskiy and M. S. Umanskiy, Moscow]

[Abstract] Reconstruction of tomographic images by expansion into orthogonal series is considered and the attainable resolution of this method is estimated, taking into account that every "point" object has nonzero dimensions and a finite luminance. Reconstruction with use of orthogonal Zernike polynomials in the presence of additive noise is described and the resolution is calculated according to the Rayleigh criterion. On this basis then determined the minimum number of series terms necessary for ensuring a given resolution, this number depending on the spectral density of the noise and increasing as the latter increases. Figures 2; references 3: 2 Russian, 1 Western.

UDC 535.317.1

Characteristics of Reconstruction of Two-Dimensional Patterns With Aid of Modified Michelson Interferometer

18600122g Novosibirsk AVTOMETRIYA in Russian
No 2, Mar-Apr 88 (manuscript received 22 Jul 86)
pp 49-53

[Article by E. I. Gelfer, V. G. Zakin and Ye. I. Mindlina, Gorkiy]

[Abstract] Reconstruction of intricately shaped two-dimensional patterns with the aid of a modified Michelson interferometer is considered, a mathematical analysis of the reconstruction algorithm revealing the characteristic features of this process. The interferometer also called a displacement or prismatic one, reconstructs the transverse space-coherence function of an undistorted optical field in terms of its modulus and phase as functions of the radius. While accurate reconstruction of the phase profile without tracking is possible only when the statistical dispersion of the random component becomes vanishingly small, tracking replaces the dispersion with a much smaller parameter so that the dispersion is in effect already scaled down. The reconstruction algorithm was tested on the letter F by numerical simulation on a BESM-6 high-speed computer. Figures 6; references 5: 2 Russian, 3 Western (1 in Russian translation).

UDC 621.372.834:538.945

Electronic Load on Superconducting Microwave Resonators

18600085d Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 33 No 3, Mar 88* (manuscript received 2 Jul 85) pp 600-606

[Article by S. N. Artemenko, V. L. Kaminskiy, and G. M. Samoylenko]

[Abstract] An experimental study of field emission and resonant high-frequency discharge in microwave resonators made of superconducting material (Nb) has confirmed that artificial aging of such resonators will suppress both effects. Two kinds of resonators were tested, one with plain cylindrical geometry (2.8 GHz resonance frequency, $2 \cdot 10^8$ no-load Q-factor) and one with a choke coupling (3.7 GHz resonance frequency, $2 \cdot 10^9$ no-load Q-factor). The plain ones had been produced by "hot" technology, with deep-vacuum high-temperature annealing after electrochemical etching and anodic oxidation. The others had been produced by "cold" technology, with machining after electrochemical etching and anodic oxidation. Both kinds were tested in the E_{010} -mode at 1.2-4.2 K temperatures. The apparatus consisted of a microwave oscillator with a frequency stabilizer and a frequency meter, a controlled modulator, and a power amplifier sending an input signal to the resonator through a directional coupler. The resonator output signal was sent through a diode to an oscillograph which also received a signal from the directional coupler through a diode and which fed a signal back to the oscillator through a frequency-deviation transducer. Another oscillograph recorded the resonator output signal directly and a roentgenometer measured the radiation emitted by the resonator. The electronic load on the resonator was recorded by a Faraday cylinder and found to obey the Fauler-Nordheim law describing the dependence of the field emission current on the microwave field intensity. It was also found to be much lighter on resonators produced by "cold" technology. The frequency shift of resonant discharge was found to increase and the resonance line to widen with increasing discharge power, with the loaded Q-factor decreasing, and both were found to decrease with increasing amplitude of the discharge voltage. Thermal cycling with the vacuum maintained during each successive cooling revealed that suppression of resonant high-frequency discharge requires removal of air from the cryogenic vessel so as to avoid its adsorption by resonator surfaces. The authors thank Yu. G. Yushkov for valuable suggestions. Figures 4; references 12: 7 Russian, 5 Western.

UDC 516.46

Active Two-Element Microwave Interferometry of Sea Surface

18600094b Kiev *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 3, Mar 88* (manuscript received 14 Apr 86) pp 263-273

[Article by A. V. Ivanov, Institute of Radio Engineering and Electronics, USSR Academy of Sciences]

[Abstract] An active correlational two-element interferometer generally including two arbitrarily spaced transmitter-receiver antennas is considered for microwave probing of the sea surface, both antennas moving at the same arbitrary velocity while transmitting and receiving radio waves of two different frequencies. Its performance in two modes of measurements is evaluated theoretically. Measuring the space-time spectrum of the surface's reflectance field is done on the basis of back-scattering in the approximation of small perturbations and according to the two-scale model. Measuring the space-time spectrum of the surface's velocity field is done on the basis of scattering and reflectance modulation. Expressions for the space-frequency resolution and the time-frequency resolution of such a two-frequency interferometer, also of a single-frequency two-antenna interferometer, are derived using the intensity of the beat line for the former and treating the latter as a special case. A correlational intensity interferometer is considered for measuring the spectral densities of reflectance modulation. References 20: 5 Russian, 15 Western.

UDC 538.561

Theory of Parasitic Radiation in Gyrotrons

18600094e Kiev *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA in Russian Vol 31 No 3, Mar 88* (manuscript received 21 Apr 86) pp 361-368

[Article by N. A. Zavolskiy, G. S. Nusinovich and A. B. Pavelyev, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] The power of parasitic radiation at harmonic frequencies in a gyrotron which has a variable longitudinal field structure and operates at the fundamental cyclotron frequency is evaluated, first under steady-state conditions and then under transient conditions. Analysis of the problem is based on the self-consistent system of the two corresponding equations. The first equation describes the change of transverse electron momentum caused by action of the high-frequency electric field, this field being static with constant amplitude in the steady state and dynamic with an amplitude which builds up in time along the gyrotron axis during the transient period. The second equation, a linear nonhomogeneous integro-differential one, describes the longitudinal structure of the fundamental field component. This system of equations is reduced to parametric dimensionless form, with the longitudinal wave number as single argument in the steady state and with the critical frequency of the operating mode as reference frequency in the transient state, which reduces the problem to problems of a gyrotron with fixed longitudinal field structure. A numerical solution has been obtained for second-harmonic and third-harmonic microwave power in a gyrotron with a Gaussian longitudinal field structure. Figures 6; references 11: 6 Russian, 5 Western.

UDC 538.561

Theory of Parasitic Radiation in Gyrotrons

18600094e Kiev IZVESTIYA VYSSHIKH

UCHEBNYKH ZAVEDENIY: RADIOFIZIKA

in Russian Vol 31 No 3, Mar 88 (manuscript received
21 Apr 86) pp 361-368

[Article by N. A. Zavol'skiy, G. S. Nusinovich and A. B. Pavelyev, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] The power of parasitic radiation at harmonic frequencies in a gyrotron which has a variable longitudinal field structure and operates at the fundamental cyclotron frequency is evaluated, first under steady-state conditions and then under transient conditions. Analysis of the problem is based on the self-consistent system of the two corresponding equations. The first equation

describes the change of transverse electron momentum caused by action of the high-frequency electric field, this field being static with constant amplitude in the steady state and dynamic with an amplitude which builds up in time along the gyrotron axis during the transient period. The second equation, a linear nonhomogeneous integro-differential one, describes the longitudinal structure of the fundamental field component. This system of equations is reduced to parametric dimensionless form, with the longitudinal wave number as single argument in the steady state and with the critical frequency of the operating mode as reference frequency in the transient state, which reduces the problem to problems of a gyrotron with fixed longitudinal field structure. A numerical solution has been obtained for second-harmonic and third-harmonic microwave power in a gyrotron with a Gaussian longitudinal field structure. Figures 6; references 11: 6 Russian, 5 Western.

UDC 621.396.22.029.7

Wideband Photoreceiver With Additive Combining of Channels for Fiber-Optic Communication Lines

18600062f Moscow RADIOTEKHNIKA in Russian
No 1, Jan 88 (manuscript received 25 Mar 87) pp 81-82

[Article by I. V. Kalmykov, N. P. Lamtyugina, Ye. A. Potylitsyn, and N. D. Simachev]

[Abstract] A wideband photoreceiver with additive combining of channels has been designed for use with high-speed fiber-optic communication lines. It contains a Si p-i-n photodiode at the input and two amplifiers: a d.c. amplifier and a wideband band-pass amplifier. The d.c. amplifier largely determines the photoreceiver time and thermal stability. The wideband band-pass amplifier, which largely determines the photoreceiver threshold power, consists of a common-emitter input stage with field-effect transistors, two galvanically coupled stages with n-type and p-type transistor respectively, and an emitter-follower output stage for matching with the channel combiner circuit. This amplifier has a resistive negative feedback loop including frequency-dependent circuits as well as resistive-capacitive circuits, one on the emitter side and on the collector side, for correction of the amplitude-frequency characteristic. Its frequency band is 200 Hz-20 MHz, that of the d.c. amplifier is 0-20 Hz. The photoreceiver combines a very low threshold power such as that of conventional photoreceiver which has a preamplifier with negative feedback and a high stability such as that of a conventional photoreceiver which has a preamplifier with differential input stage. Figures 2; references 2: 1 Russian, 1 Western (in Russian translation).

Zonal Satellite Communication Networks

18600063b Moscow VESTNIK SVYAZI in Russian
No 2, Feb 88 pp 41-42

[Article by V. A. Kupchinskiy, chief engineer, Scientific Research Institute of Radio Communication]

[Abstract] Zonal satellite communication networks formed by a central ground station and several peripheral ones for each geographical zone of the country are found to facilitate cost effective hookup of telephone service to television broadcast reception on a simultaneously operational basis. The telephone shank includes a transmitter, multistation-access apparatus, and a set of analog-to-digital converters. For the central stations is available the Gelikon 5975-6275 MHz transmitter with a power rating of 3 kW, with air cooling, and with 100 percent standby capacity. For multistation access is available the Gruppa apparatus consisting of common shank equipment and six discrete modems, data being transmitted by phase modulation of the carrier with digital flux from the analog-to-digital converters at a rate of 512 kbit/s over eight standard tone-frequency pulse-code-modulation channels. For the peripheral stations is

most suitable the Orbita-2 receiver, appropriately redesigned. Operation of the transmitters in the single-carrier mode requires only 5-15 kW microwave carrier power and only a part of the Grunt transmitting facility, which saves electric energy and thus operating cost: 5-10,000 rubles daily. Such a system designed for the Far East with one central and three peripheral ground stations, the Orbita-2 converted into a transceiver, could save about 1,000,000 rubles annually.

UDC 621.315.212

New Coaxial Trunk Cables With Single Large-Diameter Core Pairs

18600064a Moscow ELEKTROSVYAZ in Russian
No 2, Feb 88 (manuscript received 21 Jul 87) pp 26-27

[Article by A. S. Vorontsov, P. A. Frolov, S. A. Shun, and L. U. Shabayeva]

[Abstract] New coaxial single-pair cables have been developed for analog data transmission with K-3600 equipment, their diameter being much smaller than that of excessively heavy coaxial quad cables but sufficiently large to ensure a low attenuation coefficient. They are designed with polyethylene-air insulation and copper braided outer conductor. They are produced in four sizes: KMPSH 5.8/21 mm (outside diameter 30.2 plus or minus 0.6 mm, nominal mass 494 kg/km), KMPBp 5.8/21 mm (outside diameter 41.2 plus or minus 1.0 mm, nominal mass 1630 kg/km), KMPKp 5.8/21 mm (outside diameter 48.2 plus or minus 1.0 mm, nominal mass 3948 kg/km), KMPK 5.8/38 mm (outside diameter 65.6 plus or minus 1.0 mm, nominal mass 7560 kg/km). The electrical resistance of their insulation at room temperature is at least 10,000 Mohm/km between conductors and 20 Mohm/km between outer conductor and water, they can withstand a test voltage of 6 kV d.c. between conductors for 2 min, their characteristic impedance at 2.5 MHz frequency is 75 plus or minus 0.75 ohms, and the reflection coefficient at internal inhomogeneities does not exceed $3 \cdot 10^{-3}$ in KP-5.8/21 cables and $6 \cdot 10^{-3}$ in KP-5.8/38 cables. They can withstand mechanical tension loads of up to 5.0 kN (KMPHsp, KMBp), 40 kN (KMPKp), 80 kN (KMPK). Figures 1; tables 1; references: 1 Russian.

UDC 621.315.2.758.37

Nonhomogeneous Cylindrical Shield Against Helical Electromagnetic Field

18600064b Moscow ELEKTROSVYAZ in Russian
No 2, Feb 88 (manuscript received 4 Sep 87) pp 28-31

[Article by V. M. Bondar]

[Abstract] Design and performance of a composite flexible cylindrical shield keeping out the electromagnetic field of a coaxially inside or outside helical conductor are analyzed on the basis of applicable intensity ratios

characterizing both electric and magnetic field components, this method being preferred to the energy method. The shielding factors and the necessary mesh density factor as well as the attenuation coefficient for a thin shield are calculated accordingly. Numerical analysis covering frequencies up to 1 MHz reveals that disregarding all but the fundamental field mode with a space frequency equal to the number of turns in the helix will result in an error of up to 10 percent, this error being reducible by including as many space harmonics as required for a given accuracy. Figures 8; references: 7 Russian.

UDC 621.315.2.758.37

Protective Characteristics of Cable Sheaths Exposed to Pulse Currents

18600064c Moscow ELEKTROSVYAZ in Russian
No 2, Feb 88 (manuscript received 15 May 87) pp 32-34

[Article by A. A. Voronkov, S. A. Sidnev, and S. A. Timofeyev]

[Abstract] The performance of cable sheaths in communication lines is evaluated in terms of protection of cable conductors against interference pulse currents inducible by lightning discharge or by ground faults on neighboring power transmission lines. Calculations involving transformation of the sheath impedance from frequency domain into time domain, for a determination of its transient characteristic, are compared with experimental data pertaining to a 100 m long MKSAShp 4x4x1.2 cable segment. Measurements were made in a special test stand including a Rogowski loop as well as two S8-13 oscillographs, one with memory and one with voltage divider. The results confirm that the interference immunity of communication cables can be increased by decreasing the sheath impedance. Figures 4; references: 5: 1 Russian, 4 Western (3 in Russian translation).

UDC 621.315.2

History of Underwater Communication Cables

18600064d Moscow ELEKTROSVYAZ in Russian
No 2, Feb 88 (manuscript received, after revision, 16 Nov 87) pp 36-41

[Article by D. L. Sharle]

[Abstract] The history of underwater communication cables is broken down into three periods on the basis of benchmark developments and reviewed in this sequence. The 1851-1900 period saw telephone cables, first shorter submarine ones and then longer transoceanic ones. The 1900-1950 period saw armored telephone and telegraph cables, first low-frequency symmetric ones and then high-frequency coaxial ones. The 1950-1985 period saw high-frequency coaxial cables with underwater repeaters, first submarine ones with tube amplifiers, then transoceanic ones with armor or rope and tube amplifiers, finally transoceanic ones with rope support and transistor amplifiers. The fourth

period from 1985 to beyond 1990 is characterized by appearance of fiber-optic cables with underwater relays, the present state of the art being single-mode infrared-wave-length (1300 nm) fiber optics for digital transmission at a rate of 280 Mbit/s. Figures 3; tables 3; references 7: 6 Russian, 1 Western (in Russian translation).

UDC 621.396.1.019.3.029

Network Structures for Zonal Short-Wave Communication With Remote Relay Station

18600064e Moscow ELEKTROSVYAZ in Russian
No 2, Feb 88 (manuscript received 3 Jul 87) pp 42-46

[Article by O. V. Golovin]

[Abstract] Four different network structures for zonal short-wave radio communication through a remote relay station are examined, such a communication system meant to serve as an important standby for and not as a replacement of other communication systems. In the ISKRA network structure, similar to the existing one, receivers within each zone are linked to an intermediate radio station and all these radio stations are interlinked through the relay station. The drawbacks of such a structure are high cost and high energy consumption as well as poor maneuverability of automation and adaptation equipment. In the RASKAT network structure, which is a homogeneous one, entirely adequate low-power receivers are not only linked directly to the relay station through digital narrow-band channels with frequency division operating at a fixed transmission rate with common synchronization but also linked to one another within any one zone. In the MEZON network structure two remote relay stations are interlinked, one carrying a high-power wide-band multichannel transmitter and one carrying a wide-band multichannel receiver, both serving the same zone but such a separation being required by the high power of the transmitter. In the ASTRA network structure three remote relay stations arbitrarily spaced around a circle with a 2500-3500 km radius simultaneously receive signals from a zonal radio transmitter and relay them to a zonal radio receiver with optimal automatic signal selection. Figures 5; references 5: 1 Russian, 4 CCIR.

UDC 656.254:621.391.8

Possible Ways to Ensure Compatible Operation of Railroad Automatics and Digital Transmission Systems

18600073a Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 3, Mar 88 pp 16-18

[Article by S. Ye. Kats, chief specialist, and Yu. A. Lipovetskiy, chief specialist, City Telephone Communication System, V. P. Glushko, assistant professor, Leningrad Institute of Railroad Transportation Engineers, A. P. Koshelev, senior scientific associate, and V. K. Kotov, assistant]

[Abstract] Conversion of the railroad communication system to a digital one with pulse-code modulation would improve both performance of reliability, but such

a system must be electromagnetically compatible with the railroad automatic remote control system operating alongside. Interference from the latter has been found to be the major source of excessive signal distortion in the PCM-120 communication network along the Baltic railroad line. The most drastic way to ensure high-fidelity communication is to install the railroad automatic remote control network separately, which means to lay three instead of two cables. Since many two-cable lines are already available, other alternatives are sought by the Department of Electrical Communications at the Leningrad Institute of Railroad Transportation Engineers. Insertion of series low-pass filters remains problematic because of inadequate overvoltage and lightning protection. It is recommended, instead, to space repeaters, relay boxes, and semaphores in a checker-board pattern. When relay boxes and semaphores must be installed in the vicinity of repeaters, then station public-address circuits and station-to-station communication circuits should be taken out into a separate cables as a repeater is approached on the receiver side. Another recommendation is to switch railroad automatic remote control, station public-address, and station-to-station communication circuits from the forward transmission cable to the return transmission cable. Each scheme has been evaluated for improvement of communication fidelity, additional capital investment, additional operating cost, and also additional copper requirement. Figures 3; tables 1.

**Control of 43RTS-A2-ChM Radio Station
Permanently Installed Along Railroad Run**
18600073b Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 3, Mar 88 p 33

[Article by V. V. Kiselev, chief, Communications Laboratory, Sverdlovsk railroad line, M. I. Itsikson, senior electromechanic, and A. Ye. Soldatov, senior electromechanic]

[Abstract] Installation of a 43RTS-A2 VHF-FM auxiliary radio station on a permanent site along the track is proposed for improving communication between railroad dispatcher and engineer on the Sverdlovsk line, which passes through mountainous terrain. The bulk of the station equipment can be enclosed in a relay box under the thermostat, with the quarter-wavelength dipole antenna mounted on a special pole 20 m above ground. Some slight design modifications are required, namely replacing the control panel with any PPS-P industrial intercom version including a direct-current circuit and converting the 1600 Hz call-frequency oscillator built with No 6 filters into a 1000 Hz one with No 5 filters. In addition, hookup to a two-wire line through an amplifier for operation without selective ringing should be included as a permanent feature. For operation from a 24 V d.c. power supply, the current-limiting resistor should be shorted. The many advantages of a VHF radio station over

an HF one include better quality of radio signals, elimination of the need for waveguides and for corrective tuning along traction power substations, also solution of the electromagnetic-compatibility problem.

UDC 656.254.16:621.396.931

**Passive Radio Relays for Train Radio
Communication in Very-High-Frequency Bank**
18600117b Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 5, May 88 pp 6-8

[Article by A. D. Sartbayev, chairman, Department of Radioelectrical Communication, Alma-Ata Institute of Transportation Engineers, and M. I. Seydalina, engineer]

[Abstract] Two variants of "obstacle"-type passive radio relays, rectangular and annular ones, are compared from the standpoint of design optimization for improvement of VHF radio transmission above rugged terrain. The design procedure is demonstrated on a numerical example, considering a typical rough terrain with a hill or mountain and a shadow zone behind. A ring segment is shown to have better performance characteristics than a straight segment. Artificial sharpening of a mild surface asperity into an upward protruding wedge by means of opaque metal nets with not larger than quarter-wavelength mesh size beneficially raises the electric field intensity at points of radio wave reception behind the asperity. Figures 7.

UDC 656.254.15:621.376.5

**Startup and Adjustment Operations Along
PCM-120 Communications Cable Line**
18600117d Moscow AVTOMATIKA,
TELEMEKHANIKA I SVYAZ in Russian
No 5, May 88 pp 24-25

[Article by A.I. Butorin, chief, Kotlas Laboratory, Northern Railroad Line]

[Abstract] Setup and adjustment following installation of the PCM-120 digital communication line with ZKPASh 1x4x1.2 cables and with multiplexing are described stage by stage. The equipment for this line includes, in addition to two terminal stations, 2 attended and 80 unattended repeater stations as well as two remote-control stations matched with the terminal stations and with the attended repeater stations respectively. The operations included testing each line segment and all equipment by a team of two linepersons using telephone for communication and necessary instruments such as voltmeters and control boxes for monitoring test signals at 1000 Hz and 6400 Hz frequencies. The results of these tests indicate a need for better manufactured repeaters and better service communication between attended repeater stations. A repeater should have extra sockets for hookup to the service communication line and a connector for hookup of the rerouter to the phantom circuit, the latter to be cleared of asymmetry. Needed is also a universal instrument which will combine the functions of rerouting, reliability check, and signal level indication. Tables 2.

UDC 681.84.083.8:621.3.037.372

Device for Analysis of Signal Drop-Out During Digital Magnetic Tape Recording

18600111 Moscow *TEKHNICA KINO I*

TELEVIDENIYA in Russian No 4, Apr 88 pp 21-25

[Article by M. A. Nekhamkin, All-Union Scientific Research Institute of Television and Radio Broadcasting]

[Abstract] Considering that the principal consequence of signal dropout during high-density digital recording on magnetic tape is error bunching and the principal countermeasure is the use of powerful corrective codes which lower the error probability, a device has been developed for analysis of signal dropout and for quality control of magnetic tape according to the objective criterion of residual distortion. The device produces histograms of dropout length and spacing distributions as well as dropout distributions over tape depth and tape length.

The output signal of a playback amplifier with automatic gain control for setting the 1 dB level enters both an envelope detector and a clocking synchronizer. The detector converts each half-wave of this signal into a constant voltage for comparison with a threshold level so that one bit long dropouts and spaces between dropouts can be recorded. An interval counter with two inputs converts lengths to digital codes, aided by synchronizing pulses, and feeds these codes along two channels to a buffer memory for addressing and subsequent read-in to a direct-access memory in accordance with instructions from an Elektronika D3-28 microcomputer. Measurement and remote control as well as dropout data processing and display are programmed in real time on the tape, secondary data processing being done not in real time with the aid of a 128 kbyte direct-access memory forming data arrays. Not only automation but also flexibility has been built into this analyzer, for evaluation of various derivative signal and tape characteristics. Figures 3; references: 4 Russian.

UDC 621.382.2.001.4

High-Speed High-Power Diodes and Thyristors
18600128b ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 8 Oct 87) pp 7-10

[Article by S. S. Asina, candidate of technical sciences, V. L. Kuzmin, candidate of technical sciences, and A. M. Surma, engineer]

[Abstract] Two new semiconductor switching devices have been developed and designed for high-speed high-power rating, namely the DCh143-1000 diode and the TB353-1000 thyristor. The diode features a graded Pt-concentration in its structure, which makes it possible to combine an 1800 V maximum allowable repetitive reverse voltage with a 1000 A full-cycle average on-voltage current and a 0.005 ms repetitive rise time at a junction temperature of 175 deg C. The thyristor topology features a radially split feedback-control gate, a distributed n-emitter with densely packed shunting, especially of its edge, and a region with high recombination rate, which make it possible to combine a di/dt of -10 A/microsecond with a dv/dt of 50 V/microsecond at a junction temperature of 125 deg C. The diode is already produced commercially for domestic needs and also for export to Finland. The thyristor is still in the experimental and pilot production stage, the performance of prototypes indicating a capability to switch power of up to 20 MW at kilohertz frequencies. Figures 2; tables 3; references 3: 2 Russian, 1 Western.

UDC 621.382.233.026.001.5

High-Speed High-Voltage Power Thyristors
18600128c ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 9 Feb 88) pp 20-22

[Article by Ye. M. Geyfman, candidate of technical sciences, A. V. Konyukhov, engineer, I. N. Lapshina, engineer, Yu. M. Loktayev, engineer, P. B. Rabkin, candidate of technical sciences, O. V. Bazanov, engineer, and S. N. Yurkov, candidate of technical sciences]

[Abstract] The two classes of power thyristors now produced and used, namely the class of high-power and ultrahigh-power but low-speed ones and the class of high-speed but low-voltage ones, are being joined by a new class of high-speed high-voltage ones. These have been developed with computer-aided design by the Industrial Association Elektrovypryamitel (Electric Rectifier) and the All-Union Institute of Electrical Engineering imeni V. I. Lenin. They feature a p-n-p-n structure with densely packed shunting of the cathodic p-n junction and a radially split feedback-control gate. The nominal performance characteristics of these T453-800 and T453-630 thyristors are comparable with those of their AEG T760S and Siemens BStR63H foreign-made counterparts. Figures 4; tables 1; references 4: 3 Russian, 1 Western.

UDC 621.382.2.026.001.4

Application of Gate Turn-off Power Switches
18600128d ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 20 Jul 87) pp 22-27

[Article by O. G. Budatov, doctor of technical sciences, P. S. Lyshak, engineer, and S. V. Odyn, candidate of technical sciences]

[Abstract] Gate turn-off switches, combining the capabilities of turn-on thyristors and the switching mode of bipolar transistors, are characterized by nine groups of performance parameters which determine their most effective application: 1) voltage parameters of anode circuit, 2) current parameters of anode circuit, including I^2dt , 3) voltage and current parameters of blocking circuit, including gate di_{GT}/dt , 4) voltage and current parameters of blocking circuit, including gate di_{GQ}/dt , 5) triggering and blocking time parameters, 6) blocking coefficient g_{GQ} and blocking charge q_{GQ} , 7) critical rates of current rise and voltage rise, defining the dynamic range in triggering mode and in blocking mode respectively, 8) thermal parameters, 9) power parameters. A performance evaluation based on AEG, Hitachi, Toshiba data and ratings indicates that effective operation of these devices requires a damping circuit in the inverter bank, to reduce constraints on turn-off, an overcurrent protection, and a universal control-pulse shaping circuit. Figures 4; tables 2; references 10: 6 Russian, 4 Western.

UDC 621.383.233.026.019.34.001.8

Main Trends in Research and Development Pertaining to Reliability of Semiconductor Power Devices

18600128f ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 8 Dec 87) pp 44-46

[Article by V. M. Bardin, candidate of technical sciences]

[Abstract] Extensive research and development aimed at improving the reliability of semiconductor power devices, particularly rectifier and converter-inverter banks, are motivated basically by the high economic penalty of failures in service usually traceable to inadequate quality control by both producer and user. The problem is analyzed from both technical and institutional standpoints. Technically, reliability must be established in four principal failure-prone operating modes: static, cyclic, capacitive switching, current overload. Other also critical modes include operation as drive servomechanism component and multifunctional operation. The problem of reliability assurance is tackled from three positions: scientific study of degradation mechanisms, engineering-design estimation of reliability characteristics, and nondestructive or "pass - fail" testing by better methods and with better equipment. Figures 1.

UDC 621.316.925.45

**Device for Elimination of Voltage Dead-Zone
Bank in Operation of Directional Protective
Systems**

18600102b Kiev *TEKHNICHESKAYA*

ELEKTRODINAMIKA in Russian No 2, Mar-Apr 88

(manuscript received 19 Feb 87) pp 99-101

[Article by Robert Aleksandrovich Vaynshteyn, candidate of technical sciences, department head, Sergey Anatolyevich Filippov, engineer, and Svyatoslav Mikhaylovich Yudin, candidate of technical sciences, assistant professor, Tomsk Polytechnic Institute]

[Abstract] A device is proposed which eliminates the voltage dead-zone band in operation of directional protective systems when symmetric faults occur at locations near the relay, with neither the time constraint on correction owing to the difference between the free oscillation frequency of the memory circuit and the

network frequency in the case of passive protection nor the larger phase drift in the high-Q oscillatory circuit in the case of active protection. The device is based on the known principle of phase conversion during frequency multiplication and division, utilization of microelectronic and integration technologies avoiding the problem of inertia which limits the response speed. It consists of a voltage sensor and a current sensor, each followed by a shaper of square pulses and then a shaper of double-frequency synchronizing pulses, the two sensors also feeding a common trigger for an array of six NAND gates with a synchronizer within the logic structure, and a sequential shift register at the output feeding the relay. The device is designed to generate a polarizing voltage whose phase is predetermined by that of the pre-fault network voltage and whose frequency remains throughout the fault duration equal to the network frequency. Its response time does not exceed 0.01 s, its sensitivity is high and its power requirement is low. Figures 2; references: 3 Russian.

UDC 631.371:621.315.1"71"

Justification for New Electric Power Supply Centers Feeding Rural Distribution Network
18600120a Minsk IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: *ENERGETIKA* in
Russian No 5, May 88 (manuscript received 3 Mar 86)
pp 34-37

[Article by L. G. Draganova, engineer and V. L. Pruss, candidate of technical sciences, All-Union State Planning Institute and Scientific Research Institute 'Elektrosetproyekt' (Electrical Network Design), Belorussian branch]

[Abstract] Installation of new 35/110/10 kV electric power supply centers for the rural distribution network is justified on the basis of a performance analysis in terms of power-dependent voltage drops and a reliability analysis in terms of energy drain during faults or shutdown within a standard reference period of time. Calculations based on three schemes of resulting sectionalization of existing 10 kV transmission lines with A-35 conductors indicate an increase of both load capacity and reliability of the network with increasing degree of sectionalization. Figures 2; references: 3 Russian.

UDC 621.31.016.4:658.56(045)

Cost Effectiveness of Measures Taken To Improve Quality of Electric Energy
18600120b Minsk IZVESTIYA VYSSHIKH
UCHEBNIKH ZAVEDENIY: *ENERGETIKA* in
Russian No 5, May 88 (manuscript received 21 Apr 86)
pp 110-112

[Article by T. I. Polikarpova, candidate of economic sciences, Krasnoyarsk Polytechnic Institute]

[Abstract] A comprehensive analysis of the economics of improving the quality of electric energy, usually with reference to the load curve, must consider not only cost incentives for improvement and penalties for degradation but also engineering and labor costs of improvement measures. This is demonstrated on a frequency drop in an A.C. power network energized by turbogenerator sets, the penalties of such a drop including higher per-unit fuel consumption in the case of steam turbines. Some numerical estimates are made which include basic and additional as well as indirect costs of maintaining or raising the nominal network frequency in terms of kopeks per MW.h. Figures 1; tables 1; references: 3 Russian.

UDC 621.317.333.6

High-Voltage Apparatus for Testing Insulation of SF₆-Filled Totally Enclosed Power Distribution Equipment in Substations
18600121c Moscow IZVESTIYA AKADEMII NAUK
SSSR: *ENERGETIKA I TRANSPORT* in Russian
No 2, Mar-Apr 88 (manuscript received 15 Jul 87)
pp 56-62

[Article by A. I. Kuznetsov, Leningrad]

[Abstract] The design of a portable high-voltage apparatus for testing the insulation of SF₆-filled totally enclosed power distribution equipment such as power transformers in a substation is outlined, this apparatus being required to meet IEC standards and specifications for 1-min testing equipment of 110 kV, 220 kV, 330 kV voltage classes with 184 kV, 316 kV, 450 kV voltages of 50 Hz frequency respectively. The power rating of this apparatus must be 10-200 kVA for testing 110 kV equipment and 500 kVA for testing 330 kV equipment. The apparatus is designed for testing by the resonance method, its circuitry consisting of two or more transformer stages with a variable inductance shunting the primary of each and the insulation constituting a capacitance across all secondaries in series. The test voltage is applied to the primary of the first transformer, through a voltage regulator and a variable series inductance. The operation of this apparatus is analyzed on the basis of its equivalent series RLC circuit and relevant voltage-current-frequency relations. The structural design of this apparatus takes into account space and area limitations posed by SF₆-filled equipment making it inaccessible to conventional insulation-testing apparatus. A prototype using IOM-100 transformers has been built for testing 110 kV and 220 kV equipment in a substation, its performance having been found to be satisfactory. Figures 2; reference 4: 3 Russian, 1 IEC.

UDC 536.483

Thermal State of Cryogenic Current Lead-In Conductors
18600121d Moscow IZVESTIYA AKADEMII NAUK
SSSR: *ENERGETIKA I TRANSPORT* in Russian
No 2, Mar-Apr 88 (manuscript received 27 Nov 84, after
revision 15 Apr 85) pp 111-116

[Article by I. Kh. Rudman, L. A. Grenaderova and N. G. Grinchenko, Kharkov]

[Abstract] The thermal state of current-carrying lead-in conductors in a cryostat is analyzed theoretically on the basis of the corresponding system of two differential equations in a dimensionless space coordinate which describe the heat balance between conductor and coolant, assuming a constant thermal conductivity of the conductor material and a linear temperature dependence of its electrical resistivity. This system of equation is reduced to dimensionless form by introduction of four

dimensionless groups including the Stewart number and the normalized conductor temperature. It is solved for boundary conditions of the first kind, ignoring the temperature dependence of the conductor-to-coolant heat transfer coefficient and of the constant-pressure specific heat characterizing the coolant. Calculations based on the analytical solution yield the dependence of the thermal fluxes at both hot and cold ends of the conductor on those four dimensionless quantities. Numerical calculations for conductors of M1 copper and M3 copper have yielded the dependence of the specific thermal influx Q_0/I referred to the conductor current I on the specific mass flow rate of coolant G/I referred to the conductor current I as well as on the specific conductor current I_1 , referred to the conductor cross-section area s and length l , under conditions of ideal heat transfer (Stewart number approaching infinity) and under real conditions (Stewart number equal to 50), also in the case of a copper conductor shunted by a superconductor. Figures 4; references 10: 4 Russian, 6 Western.

UDC 621.039:658.386.08

Standardization of Dynamic-Logic Modules for Modeling Nuclear Power Plants

18600126a Minsk IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: ENERGETIKA
in Russian No 6, Jun 88 (manuscript received after
revision 1 Feb 88) pp 84-85

[Article by Ye. A. Blinov, candidate of technical sciences, and M. I. Kolodyazhnyy, engineer, Northwestern Polytechnic Correspondence Institute]

[Abstract] Training simulators which represent situations encountered by control operators in nuclear power plants are designed on the basis of mathematical models consisting of differential, algebraic, and logic equations and the design problem is most economically tackled by subdividing the plant into autonomous subsystems and modeling each with standard dynamic-logic modules. Each subsystem is described by a set of output quantities functionally depending on four sets of input quantities which represent analog perturbations, initial conditions, coefficients, logic conditions respectively and on time. The algorithms of modules for modeling these subsystems have been standardized in an engineering language of the "fill empty spaces" type, each module consisting of four functional minimodules for operating on those four sets of input quantities. For the purpose of design and performance analysis, all auxiliary equipment including valves and regulators as well as pumps is classified into seven groups for modeling with these standardized modules and this decreases software costs. Figures 1; references: 3 Russian

UDC 621.316.925

Microprocessor-Aided Synthesis of Polyphase Impedance Relays

18600126b Minsk IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY: ENERGETIKA
in Russian No 6, Jun 88 (manuscript received
28 Feb 86) pp 12-15

[Article by A. S.-S. Saukhatas, candidate of technical sciences, and V. A. Shabanov, candidate of technical sciences, Riga Polytechnic Institute imeni A. Ya. Pelshe]

[Abstract] Design and performance optimization of polyphase impedance relays for automatic control and protection of power systems are reduced from synthesis on the basis of phasor diagrams in the complex plane to synthesis by arithmetic operations on orthogonal projections of voltages and currents programmable for a microprocessor. Figures 3; references: 5 Russian.

UDC 621.382.233.026.001.8

New Types of Optron Power Thyristors

18620128a Moscow ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 8 Oct 87) pp 5-6

[Article by R. I. Rybak, engineer, N. A. Tetervova, candidate of technical sciences, S. N. Belaya, engineer, and O. S. Nasekan, engineer]

[Abstract] The existing series of optron power thyristors with current ratings up to 80 A designed for switching under voltages up to 1200 V is to be supplemented with devices of a new type capable of switching under voltages up to 2000 V. This new type combines operation of an optron thyristor and of an optron triac (optotriac) a light-controlled alternating-current switch. Its five-layer structure combines a forward thyristor and a reverse one, connected in parallel-opposing inside the common chip. A performance evaluation based on the physical model and the equivalent-circuit relations indicates a dv/dt withstand capability of 500-1000 V/microsecond without loss of photosensitivity. Figures 4; references 6: 4 Russian, 2 Western.

UDC 621.373.1.004

Generation of Continuous Harmonic High-Frequency Oscillations by Means of Reversibly Switchable Dynistors

18600128e ELEKTROTEKHNIKA in Russian
No 5, May 88 (manuscript received 8 Oct 87) pp 28-30

[Article by I. V. Gudushin, engineer, I. Yu. Kudrayavtsev, engineer, S. V. Korotkov, candidate of technical sciences, E. V. Syrnikov, doctor of technical sciences, and V. V. Topolov, candidate of technical sciences]

[Abstract] A new semiconductor device, a reversibly switchable dynistor, has been developed at the Institute of Engineering Physics imeni A. F. Ioffe (USSR Academy of Science) for the basic purpose of switching current pulses of short duration but large amplitude in long intervals. This device is essentially a thyristor without gate

and reverse conductance. It is triggered by a short reverse pumping current pulse, with a turn-on time shorter than 1 microsecond and a turn-off time up to a few microseconds, but nevertheless usable for a generator of continuous harmonic high-frequency oscillations. One such scheme is a multicavity series-resonance inverter generating harmonic oscillations with a period much shorter than the electrical recovery time for the basis thyristor structure. A performance evaluation based on circuit analysis and experimental data confirms the feasibility of designing such an oscillator with a power rating of approximately 40 kW for switching current pulses of up to 2000 A amplitude, with the thyristor recovery time within the 0.010-0.040 ms range and the average anode current minimized to 300 A. Figures 2; references: 3 Russian.

UDC 621.372.8

Electrical and Elektothermal Processes Occurring During Microwave Heating of Metal Conductors in Motion

18600131a Kiev TEKHNIЧЕСКАЯ
ELEKTRODINAMIKA in Russian No 3, May-Jun 88
(manuscript received 22 Apr 87) pp 15-22

[Article by Aleksandr Radiyevich Bedyukh, junior scientific associate, Vladimir Vasilyevich Zagorodniy, engineer, and Tatyana Vasilyevna Parubocha, senior engineer, Kiev State University, Fedor Alekseyevich Kotenev, senior scientific associate, Institute of Electrodynamics, UkSSR Academy of Sciences, Kiev]

[Abstract] The feasibility of continuous heat treatment of metal conductors by drawing them through a microwave electromagnetic field is examined theoretically, the problem being necessarily split into an electrodynamical one and an electrothermal one. The electrodynamical problem is formulated and solved for a round cylindrical conductor drawn through holes in the two wider opposite walls of a rectangular waveguide at right angles to these walls, letting the radius of the conductor be much smaller than their width. The electrothermal problem is formulated and solved for the same conductor drawn through those walls at given constant velocity. The analytical solution to both problems yields the microwave power absorbed by this conductor for heating and provides a basis for optimizing the process and equipment so as to ensure the optimum mode of heat treatment. Figures 4; references: 4 Russian.

UDC 621.317.3/4

Electrical Resistance of Cavity Loop in Inductive Conductance Transducer

18600131b Kiev TEKHNIЧЕСКАЯ
ELEKTRODINAMIKA in Russian No 3, May-Jun 88
(manuscript received 22 Jun 87) pp 23-25

[Article by Vladimir Alekseyevich Derniy, section manager, Special Design and Manufacturing Engineering Office, Institute of Electrodynamics, UkSSR Academy of Sciences]

[Abstract] An engineering formula is derived for calculating the electrical resistance of the cavity loop in

inductive conductance transducers, such devices being used for electrophysical measurements in conducting fluids. The formula is based on classical analytical expressions for both radial and axial components of the electric field intensity in the loop and for the current flowing through the inner transducer cavity as well as across the lateral cylinder surface, in the quasi-static low-frequency approximation and with the electric double layer taken into account. The formula, derived on the basis of an ideal transducer, was verified experimentally on a real one and found to be much more accurate than the conventional simpler formula used in determination of hydrophysical characteristics such as salinity of sea water. Figures 1; references 7: Russian.

UDC 621.311:621.365

Electromagnetic Energy Converters in Power Supplies for Magnetohydrodynamic Apparatus

18600131c Kiev TEKHNIЧЕСКАЯ
ELEKTRODINAMIKA in Russian No 3, May-Jun 88
(manuscript received 3 Feb 88) pp 26-33

[Article by Boris Pavlovich Borisov, candidate of technical sciences, department head, Institute of Electrodynamics, UkSSR Academy of Sciences, Kiev]

[Abstract] A typical 3-phase A.C. MHD apparatus for processing liquid metal in a pumping-heating-casting plant includes two or more separately supplied electromagnetic energy converters, basically of two types: single-phase inductor and single-phase electromagnet. Following a theoretical analysis of the energy conversion process on the basis of circuit theory and with the aid of phasor diagrams, three schemes of energizing such converters with appropriate controls through autotransformers and capacitors are evaluated with the aid of hodographs. An arrangement with parallel and series capacitor banks, one set for the inductor and one set for the electromagnet, is proposed as means to ensure phase stabilization during voltage regulation. Figures 6; references: 7 Russian.

UDC 621.362.2.027.3

Transistorized High-Voltage Electric Power Supplies

18600131d Kiev TEKHNIЧЕСКАЯ
ELEKTRODINAMIKA in Russian No 3, May-Jun 88
(manuscript received 18 Jun 87) pp 39-46

[Article by Igor Alekseyevich Krishtafovich, candidate of technical sciences, senior scientific associate, Institute of Electrodynamics, UkSSR Academy of Sciences]

[Abstract] Three methods of stepping up voltages in high-voltage electric power supplies built with transistors and thus in a compact version are evaluated comparatively from the standpoint of optimum design and

performance characteristics. The first method is transformation of alternating voltage. The second method is addition of voltages. The third method is build-up of electromagnetic energy. Circuit analysis of each scheme and the corresponding power relations indicate that the second scheme is the best one in terms of reliability, high electromagnetic-interference immunity, fast response to

control action, and standardizability. The first scheme, limited by stray capacitance to small step-up ratios, features a high degree of structural simplicity. The third scheme has the highest short-circuit withstand capability and offers the possibility of paralleling in lieu of special voltage equalization measures. Figures 4; references 20: 18 Russian, 2 Western.

UDC 621.315.55:537.312.62

Superconductors in Weak Alternating Magnetic Fields

18600102a Kiev TEKHNIЧЕСКАЯ

ELEKTRODINAMIKA in Russian No 2, Mar-Apr 88

(manuscript received 30 Dec 86) pp 7-11

[Article by Vladimir Yevdokimovich Miloshenko, candidate of physico-mathematical sciences, assistant professor, Igor Mikhaylovich Shushlebin, engineer, and Igor Mikhaylovich Golev, senior engineer, Voronezh Polytechnic Institute]

[Abstract] The behavior of thin superconductor plates flexurally or torsionally vibrating in a constant external magnetic field is analyzed theoretically. Such a motion of a superconductor is known to induce alternative surface magnetic fields, while the effect of the external magnetic field is to change the frequency and the damping of those vibrations by an amount which depends on its intensity. The dependence of both logarithmic decrement and relative frequency deviation on the intensity of the external magnetic field is characterized by a peaking of each, most pronouncedly in the case of Nb in the mixed state, at a magnetic field intensity typically within the 15-30 mA/m range. The magnitudes of these peaks not only decrease with higher natural frequency but also depend on the orientation of the external magnetic field and on the crystalline structure of the metal. Since energy dissipation during viscous motion of vortices and irreversible deformation of the vortex structure does not adequately explain this anomaly, action of an alternating magnetic field with a very small amplitude relative to the external constant magnetic field is viewed from the standpoint of the phenomenological "complex magnetic polarizability" model including the skin effect as well as the Meissner effect. The dependence of both logarithmic decrement and relative frequency deviation on the dissipation tensor has been established experimentally, the magnitude of the dissipation tensor being different in Meissner, mixed, and normal states. The dependence of both complex electrical conductivity and magnetic permeability on the dissipation tensor according to this model has been established theoretically. This model yields no general analytical description of that dependence for a metal in the mixed state, only in the two limiting high-frequency and low-frequency approximations. For a type-2 superconductor in the mixed state with a pinned vortex structure, general relations for the complex electrical conductivity and the pinning frequency have been obtained on the basis of the Gittleman-Rosenblum model. Figures 2; references 16: 11 Russian, 5 Western.

UDC 621.317.44.049.004.14

Use of Phase Phase-Sensitive Circuits for Magnetic Measurements

18600110e Moscow IZMERITELNAYA TEKHNIKA

in Russian No 3, Mar 88 pp 41-43

[Article by Yu. N. Maslov and S. L. Shapiro]

[Abstract] Use of a phase-sensitive circuit for magnetic measurements involving highly nonlinear quantities or signals such as for inspection of devices like choke coils or for coordination with electromagnetic primary transducer has been proposed, only one winding on a magnetic core being required then. Measurement by this method is based on quasi-static magnetization reversal with a hysteresis cycle in which maximum induction and maximum field intensity are reached at the same instants of time. Taking into account the field dependence of both winding inductance and core loss, the performance of such a circuit is analyzed with the aid of induction-time diagrams and with the differential inductance, rate of change of flux linkages, as a circuit parameter correctly lumping the relevant electrical and magnetic characteristics. Operation of such a circuit in an a.c. instrument bridge is described and inductance measurement as well as separation of iron loss and copper loss are analyzed, including errors and especially those caused by nonlinearity or nonsinusoidality, on the basis of the appropriate equivalent circuit diagram and as basis for design of such a bridge. Figures 2; references: 5 Russian.

UDC 621.317.42.089.52

Possibilities of Lowering Sensitivity Threshold of Ferroprobes

18600110f Moscow IZMERITELNAYA TEKHNIKA

in Russian No 3, Mar 88 pp 43-45

[Article by Yu. V. Afanasyev]

[Abstract] Both theoretical and experimental research concerning noise in ferroprobes which limits their sensitivity threshold is reviewed, possible ways to lower the threshold deriving from the dependence of the noise level on magnetostriction and magnetic anisotropy as well as on the temperature as the latter approaches the Curie point for the ferroprobe materials. Accordingly, "amorphous" ferroalloys are being developed which not only are crystallographically isotropic and mechanically much stronger than conventional alloys but also are more readily annealed at 300-450°C for 0.2-1 h in a magnetic field. Alloying with Cr lowers the Curie point. Quenching in water stimulates formation of a costate structure with 80° domain walls and their detachment, which results in a lower coercive force and a higher initial magnetic permeability. Such alloys are $\text{Fe}_{70-x}\text{Si}_{15}\text{B}_{15}$, $(\text{Fe}_x\text{Co}_{70-x}\text{Si}_{15}\text{B}_{15})_{95}\text{Cr}_5$, $(\text{Fe}_3\text{Co}_{67}\text{Si}_{15}\text{B}_{15})_{90}\text{Cr}_7$. Figures 2; references 27: 19 Russian, 8 Western (3 in Russian translation).

UDC 535.231.11.09

Power Meter for Low Levels of Optical Radiation
18600110c Moscow IZMERITELNAYA TEKHNIKA
in Russian No 3, Mar 88 pp 23-24

[Article by O. Ye. Zakurenko and V. M. Kuzmichev]

[Abstract] A nonselective instrument has been developed and built for measuring low power of optical radiation such as that in fiber-optic systems. Its operating principle is automatic substitution, namely thermally equivalent power of direct electric current in a heat-sensing element for the power of optical radiation absorbed by the radiation-sensing element. The instrument includes a primary transducer and an output device. A duralumin flask inside a thermally insulating ebonite jacket, the transducer housing, contains a Pi-form cantilever bracket of acrylic glass fastened to the bottom. In the two slots of this bracket, on thin glass cross-bars, are located respectively a measuring receiver and a compensating receiver. Each receiver is a disk 6 mm in diameter made of 0.020 mm thick galvanically oxidized copper foil. They are separated by a copper shield with corrective thermal shunts also made of galvanically oxidized copper foil. To the back side of each disk at the center is attached, with BF-2 adhesive, a TSh-1 thermistor, both thermistors having identical characteristics. The sought radiation power is equal to the reading by the M3-22 output device divided by the transducer efficiency, the latter being established by electrical calibration against a heater coil making solid contact with the transducer and by calibration against a standard reference such as a compensation calorimeter with a Peltier thermoelectric cell. Averaging the results of both calibrations, after analysis of this errors, has yielded a transducer efficiency of 0.244 over the 405-1,129 nm range of radiation wavelengths corresponding to a 0.989-0.959 absorption coefficient. The indicatrix of the transducer was measured with a probing light beam 2 mm in diameter. The fundamental error of the instrument was calculated by combining all noneliminable systematic measurement errors. Figures 2; tables 1; references: 1 Russian. T

UDC 535.32:534.29

Characteristics of Nonreciprocal Acoustooptic Effect

18600113c Moscow RADIOTEKHNIKA I
ELEKTRONIKA in Russian Vol 33 No 4, Apr 88
(manuscript received 22 Jul 86) pp 814-818

[Article by S. N. Antonov, P. V. Poruchikov, O. A. Byshevskiy and P. M. Vetoshko]

[Abstract] Characteristics of phase-nonreciprocal acoustooptic interaction are analyzed, for an explanation of discrepancies between theoretical and experimental data. An experimental apparatus with a simple light-diffraction scheme is considered, namely a single-pass interferometer consisting of three semi-transparent plane mirrors with the acoustooptic cell between two of

them and an acoustooptic modulator followed by a collimator and then a diaphragm which sizes the parallel light beam (630 nm) from an He-Ne laser after it has been modulated by a sound beam (38 MHz) from a LiNbO₃ crystal. Discrepancies between results based on evaluation of experimental data and results based on theoretical analysis of acoustooptic interaction in the Bragg mode are attributed to appreciable attenuation of sound waves, which widens the range of phase nonreciprocity but prevents attainment of 100 pct diffraction efficiency. The authors thank G. Ye. Zilberman for discussion of the results and V. V. Proklov for attentiveness and support. Figures 2; references 8: all Russian.

UDC 621.373.826

Angular Resolution of Adaptive Telescope
18600116a Leningrad IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY:
PRIBOROSTROYENIYE in Russian Vol 31 No 4,
Apr 88 (manuscript received 9 Feb 87) pp 59-63

[Article by G. N. Maltsev]

[Abstract] Designing a telescope with adaptive compensation of atmospheric distortions is considered, an important parameter being its angular resolution and the latter depending principally on phase distortions in the incident optical signals. Formation of images under such conditions is therefore analyzed, on the basis of the distribution of average signal intensity in the image plane, the angular resolution then being determined by the dimensions of the region within which the optical transfer function of the "telescope-atmosphere" system is equal to its principal value. As special cases are considered that of an ideal undistorted coherent incident signal and that of a nonadaptive telescope, whereupon two modes of adaptation are considered for a telescope with a composite mirror: by controlling the mean wavefront phases and local wavefront slopes within each mirror element or much simpler by controlling the overall mean wavefront phases only. In the first mode the diffraction limit of angular resolution is attained already with small ratios of entrance pupil diameter to mirror element diameter, the latter referred to the plane of the entrance pupil, with three degrees of freedom for each mirror element. In the simpler second mode larger ratios of the two diameters are required and the degrees of freedom for each mirror element are reduced to one. Figures 2; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 629.7.054.5

Algorithms of Estimating Coordinates of Images of Point Radiators in Opto-Electronic Instrument With Multielement Photodetector

18600116b Leningrad IZVESTIYA VYSSHIKH
UCHEBNYKH ZAVEDENIY:
PRIBOROSTROYENIYE in Russian Vol 31 No 4,
Apr 88 (manuscript received 4 Feb 87) pp 63-68

[Article by V. S. Pashkov and N. A. Tideman, State Institute of Optics imeni S. I. Vavilov]

[Abstract] The problem of accurately estimating the coordinates of images in an optoelectronic instrument

with a photodetector which constitutes an array of charge-transfer, charge-coupled, or charge-injection devices is reduced to an error analysis, taking into account scattering and defocusing. Three applicable methods are comparatively evaluated on the basis of computer simulation for four different objectives with approximately equal viewing angles: 1) basic one mirror and one lens; 2) one mirror and one lens with large aberrations; 3) one mirror and one lens with compensator; 4) mirrors only with compensator. The results of calculations by the weighting method, by the method of least squares, and by the method of truncated Fourier series indicate that both the brightness distribution over an image and the ratio of image dimension to dimension of one photodetector element determine which of these algorithms will yield the most accurate estimate. Figures 2; references 8: 6 Russian, 2 Western.

UDC 621.398:681.7.068.2

Multichannel Telemetering Instrument With Fiber-Optic Transmission Lines

18600116c Leningrad IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian Vol 31 No 4, Apr 88 (manuscript received 23 Dec 86) pp 74-77

[Article by Yu. O. Barmenkov, M. I. Belovolov, N. M. Kozhevnikov, A. V. Kuznetsov, M. Yu. Lipovskaya, V. I. Molotkov, Ye. I. Potapov, and M. D. Sadovskiy, Leningrad Polytechnic Institute imeni M. I. Kalinin]

[Abstract] A multichannel optical telemetering instrument has been designed and built in each channel of which the optical analog signal coming from the probe is converted into frequency-modulated current and the latter pumps a light-emitting diode, the light emitted by the latter being intensity-modulated prior to its transmission over a multimode fiber-optic line through a Y-coupler to the multimode fiber-optic trunk. The composite signal formed in this trunk is fed to a photodiode which converts it into frequency-modulated voltages. These are first amplified and then demodulated by selective detectors for subsequent information processing. The commercially available ILPN-301-1 light-emitting diodes in all channels operate at the 850 nm wavelength and are each coupled through a focan adapter to the fiber-optic output line. The instrument was tested and found to operate over the 10^4 - 10^7 Hz frequency range with a sensitivity of 10^{-3} pct and a dynamic range of 60 dB. The decoupling between channels is at least 60 dB and each channel draws a power of 0.7 W. Article was submitted by Department of Radiophysics. Figures 3; references 7: 6 Russian, 1 Western (in Russian translation).

UDC 621.397:621.385

Apparatus on Basis of LI-702 Supravidicon for High-Sensitivity Recording of Two-Dimensional Images

18600122a Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 88 (manuscript received 29 Jun 87) pp 20-26

[Article by Yu. V. Bondarenko, V. Ya. Budtsev and A. N., Kasperovich, Novosibirsk]

[Abstract] An apparatus for high-sensitivity recording of two-dimensional optical images is described, its basic component being an LI-702 scanning-transmitting supravidicon television camera with a Si-target and recording being done directly in the memory of an Elektronika-60 minicomputer with a capacity boosted by addition of a 16-byte buffer memory. The two television monitors, an image displaying screen and a spectrum displaying screen, are controlled through a CAMAC crate serving as interface to the computer. This crate contains, in addition to the control module with a high-speed direct-access memory and an 8-bit analog-to-digital converter on a 1107PV2 integrated-microcircuit chip, also a camera-scanner drive control for spectrum recording and a 106A crate monitor. High performance indicators of this apparatus are attained owing to special design of the supravidicon target, which ensures stabilization of the low random noise and smoothing of the hum within a storage time of up to 128 frames. The authors thank V. M. Efimov for fruitful discussions during setup of the experiments and for discussing the results. Figures 7; references: 2 Russian.

UDC 531.715

Dependence of Range of Angle Measurement on Orientation of Porro Prism in Interferometer

18600122e Novosibirsk AVTOMETRIYA in Russian No 2, Mar-Apr 88 (manuscript received 19 Aug 87) pp 40-43

[Article by G. A. Lenkova, Novosibirsk]

[Abstract] Angle-of-rotation measurement with laser interferometer is considered, two identical Porro prisms being mounted rigidly on a common support and symmetrically with respect to the axis of rotation. The range of measurable angles, which depends on both location and orientation of the prisms, is determined on the basis of applicable geometrical relations characterizing two possible configurations: the edges of both prisms in either one plane or in two planes. The first configuration is preferable from the standpoint of minimum light scattering by the prism edges. The second configuration ensures a better correspondence between prism orientation and direction of light polarization. Figures 3; references: 2 Russian.

UDC 535.8

Laser-Doppler Anemometer With Time Selection of Orthogonal Velocity Vector Components

Novosibirsk AVTOMETRIYA in Russian

*No 2, Mar-Apr 88 (manuscript received 13 May 87)
pp 43-49*

[Article by P. Ya. Belousov, Yu. N. Dunishchev, V. G. Meledin and V. A. Pavlov, Novosibirsk]

[Abstract] A laser-Doppler anemometer for simultaneous remote measurement of two orthogonal velocity vector components is described in which separation of the two respective optical signals in time ensures full utilization of the laser power. The instrument operates in the backscattering mode with either acoustooptical or electrooptical polarization and channel switching. For acoustooptical switching has been selected a pair of ML-201 traveling-wave modulators operating in the Bragg mode at a frequency of 80 MHz. For electrooptical switching has been selected an ML-102 modulator driven by half-wave rectified voltage the polarized laser beam passing through this switch and matching optics before being split into two orthogonally polarized halves with a 5 MHz frequency difference between them. This frequency difference is established by a pair of ML-201 acoustooptic modulators operating in the Bragg mode at 82 MHz and 77 MHz frequency respectively. The performance of the anemometer with either method of switching is characterized by a frequency-to-velocity conversion coefficient of 165 kHz.s/m, a Doppler frequency range of 10 MHz, and a maximum channel switching frequency of 300 kHz. The space resolution element is an ellipsoid, with a 0.300 mm long major semiaxis and 0.015 mm long both minor ones when measurements are made from a distance of 0.7 m in water. The recording rate is up to 10^5 particles per second. Data are processed by the pulse count method with the aid of a computer and a CAMAC crate. The instrument operates autonomously and in the continuous mode with either analog or digital read-out. It was tested on a large hydrosphere with a 1.0 W Ar-laser (480 nm wavelength) and with a 0.2 W Kr-laser (650 nm wavelength) at a distance of 0.7 m and 1.5 m respectively. The authors thank S. F. Shulzhenko and I. A. Pokhalchuk for assistance. Figures 5; references 4: 3 Russian, 1 Western.

UDC 681.7.028:621.2.08

Method of Identification of Scanning Radiometers for Various Velocities of Object Moving in Field of View

18600124a Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 88 (manuscript received 7 May 87) pp 4-6

[Article by A. P. Zakharnev]

[Abstract] A method of identification of scanning radiometers, namely of estimating their transfer functions for various velocities of moving objects within the field

of view, is proposed which does not require their direct experimental determination at each velocity of the object. It involves separately estimating the transfer function of the receiver and that of the electronic part. Separation of space and time lags is achieved by use of appropriate test signals and on the basis of response analysis. The errors of modulus and phase estimation are calculated analytically for a theoretical evaluation of the method in terms of accuracy. Assuming that the errors pertaining to one of the two radiometer components are statistically independent of those pertaining to the other. The method has been validated experimentally. Figures 3; references 8: 6 Russian, 2 Western.

UDC 621.357.6(031)

Fabrication of Metal Matrix for Multiple Copying of Phase-Relief Holograms

18600124b Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 88 (manuscript received 5 Feb 87) pp 33-35

[Article by A. M. Faberov, V. P. Smayev, A. D. Galperin, L. N. Vasilyeva and T. M. Sinitsyna]

[Abstract] The metal matrix for multiple copying of phase-relief holograms is produced by a galvanization process either indirectly from a polymer replica of the original, the latter having been recorded on a photothermoplastic materials which is then heat treated, or directly from the original recorded on a photoresist material. These methods are not necessarily adequate for a sufficiently large number of copies. Most effective has been found to be deposition of a copper rather than silver film on the surface of the polymer replica and subsequent deposition of the nickel matrix on top. Excellent results including adequate mechanical strength were obtained experimentally, with the Cu film deposited under a vacuum of $5.3 \cdot 10^{-3}$ Pa over a period of 60 s so that its thickness reached about 20 nm. References 11: 9 Russian, 2 Western (1 in Russian translation).

UDC 535.34:538.216.2

Optical Monitor for Deposition of Multilayer Coatings With Unequally Thick Layers

18600124c Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 88 (manuscript received 1 Apr 87) pp 35-36

[Article by G. V. Panteleyev and A. A. Zhuravlev]

[Abstract] An accurate method of optically monitoring the deposition of multilayer coatings with unequally thick layers of two different materials has been developed, all layers being checked photometrically against a control specimen with light of the same optimum wavelength. The monitor includes a set of interference light filters covering the 350-1100 nm range of wavelengths in 10-15 nm wide bands. Stabilization of the electric power supply for the amplifiers and the brightening lamp

reduces the read-out error to 1/200 of full deflection of the indicator needle at maximum sensitivity and with compensation. The monitor was tested in an experimental deposition of a four-layer ZnS/MgF₂ coating transparent to light of 450-650 nm wavelengths, with the substrate heating up to 130 deg C. Figures 1; references 3: 1 Russian, 2 Western (1 in Russian translation).

UDC 537.533.335

Dependence of Field Distribution Along Optical Axis of Magnetic Lenses on Location of Excitation Windings

18600124d Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 88 (manuscript received 21 Feb 87) pp 39-41

[Article by P. A. Stoyanov and A. V. Freydmann]

[Abstract] Design and performance of a superhigh-voltage electron microscope with magnetic lenses are analyzed, such a microscope having been developed and built for operation with accelerating voltages up to 2 MV. It contains six magnetic lenses: one projecting, one diffracting, three condensing, and one intermediate. The cores of all electromagnets are made of pure iron and those for three of the lenses (projecting, diffracting, intermediate) have pole shoes made of Permendur. The excitation windings for all the lenses have been split into separately energized and separately on-off switchable modules: nine for the projecting lens and six for each of the other lenses. The performance of each lens depends largely on the field distribution along its optical axis, which in turn depends on the location of the excitation

winding modules. An analysis of this relation reveals that this dependence, while negligible as long as the lens operates below saturation, becomes appreciably strong in the saturation mode. Symmetry of the winding distribution is an essential factor here, symmetric excitation ensuring maximum magnetic induction where the magnetic field intensity peaks and lowest at the edges. Figures 3; references 3: 2 Russian, 1 Western.

UDC 621.384.3

Luminescent Light Concentrators

18600124e Leningrad OPTIKO-MEKHANICHESKAYA PROMYSHLENNOST in Russian No 3, Mar 88 (manuscript received 10 Jun 87) pp 47-55

[Article by M. B. Levin, A. S. Cherkasov and V. K. Baranov]

[Abstract] Following a summary of the theory of luminescent light concentrators including definition and evaluation of their most important performance characteristic, namely the energy concentration factor representing the relative increase of electric power generated by a solar cell upon insertion of such a concentrator, known luminophor materials are surveyed and their characteristics are comparatively evaluated on the basis of available theoretical and experimental research data. Design optimization of luminescent light concentrators is considered next and several practical applications are described. The review concludes with latest development trends in both science and engineering of solar energy conversion. Figures 7; tables 2; references 83: 12 Russian, 71 Western.

UDC 621.391.64

Maximum Dark Current in Photodetector of Optical Receiver

18600062e Moscow *RADIOTEKHNIKA* in Russian
No 1, Jan 88 (manuscript received, after revision,
6 Mar 87) pp 75-77

[Article by A. N. Dorofeyev]

[Abstract] For the purpose of design and sensitivity analysis of photoreceivers with direct detection and amplification of the intensity-modulated optical carrier, necessary for selection of the material and determination of the optimum gain as well as for avoidance of deep cooling, the maximum possible dark current in the photodetector is calculated as the main factor limiting the signal-to-noise power ratio. With noise characterized as an additive mixture of the dark current and the current generated by background light, the dependence of the signal-to-noise ratio including its maximum value and of the optimum gain as well as of the minimum receivable power representing the photodetector sensitivity on the dark current can be used for determining any two of these four quantities when the other two are known. References: 10 Western.

UDC 621.382

Determination of Energy Relaxation Time for Hot Electrons in n-GaAs by Resonator Method With Computer-Aided Evaluation of Readings

18600094d Kiev *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOFIZIKA*
in Russian Vol 31 No 3, Mar 88 (manuscript received
5 May 86) pp 353-360

[Article by S. V. Plaksin, Institute of Engineering Mechanics, UkSSR Academy of Sciences]

[Abstract] Use of an instrument resonator which ensures adequately strong interaction of microwaves and semiconductor materials for measurement of the properties of such materials is demonstrated on determination of the energy relaxation time for hot electrons in Gunn-effect devices with intervalley electron transfer, specifically in n-GaAs structures, in electric fields above the threshold level. The specimen covers a hole in one of the wider resonator walls, the resonator formed by a regular waveguide segment with rectangular $1.8 \times 3.6 \text{ mm}^2$ cross-section operating in the TE_{102} -mode. The measurable resonator parameters, namely its no-load Q-factor and natural frequency in this mode, can in this configuration and by the method of small perturbations be related to the parameters of the semiconductor device and particularly its surface impedance, on which the energy relaxation time for electrons depends. Multiple reflections of microwaves in the device by its various layers are taken into account by equivalent input impedances, considering the thickness of each layer and the dielectric permittivity of its material. Calculations of the microwave

conductivity in the range of hot electrons and subsequently of their energy relaxation time according to special algorithms have been programmed in PL/I language for a YeS-1045 computer. Figures 4; references 16: 8 Russian, 8 Western (1 in Russian translation).

UDC 621.382.537.312.62

Differential Encoding in Analog-to-Digital Converters on Josephson Junctions

18600119a Moscow *MIKROELEKTRONIKA*
in Russian Vol 17 No 3, May-Jun 88 (manuscript
received 20 Apr 87) pp 206-213

[Article by S. V. Rylov, V. K. Semenov and K. K. Likharev, Moscow State University imeni M. V. Lomonosov]

[Abstract] A new method of analog-to-digital conversion with Josephson junctions is proposed, one which utilizes the negative differential inductance of these junctions for boosting the amplification of the input signal and thus combines fast read-out of the lower-order bits with restoration of the higher-order bits without requiring high-precision components. A conventional parallel-read-out converter containing a parallel array of comparators is followed by a differentiating stage, a format expander, and an integrating stage. The performance characteristic of an 8-bit or longer device with such a structure, featuring high accuracy as well as high speed, is derived from the corresponding condition for continuity. The input converter stage can be supplemented with a preamplifier using parametric quantrons or fast-single-quantum logic. Both converter and first differentiator can be replaced with a sequential analog-to-digital converter and a reversible counter, with the single-junction interferometer replaced by a double-junction one generating single-quantum pulses and connected to two identical Josephson pulse amplifier-transmission lines. Figures 5; references 18: 3 Russian, 15 Western.

UDC 621.382

Measuring Speed of Field-Effect Transistor With Aid of Picosecond Optoelectronic Instrument

18600119b Moscow *MIKROELEKTRONIKA*
in Russian Vol 17 No 3, May-Jun 88 (manuscript
received 3 Apr 87) pp 214-218

[Article by E. Adomaytis, A. Galvanauskas, Z. Dobrovolskis, A. Krotkus, Yu. K. Pozhela, E. Zhilinskas and S. Yanushonis, Institute of Semiconductor Physics, LiSSR Academy of Sciences]

[Abstract] An optoelectronic instrument has been developed for measuring the speed of field-effect transistors by triggering it with laser pulses of picosecond duration. As the source of pulses is used a YAG:Nd laser with passive mode locking in 3274 dye solution, pulses of 1060 nm radiation being emitted at a repetition rate of 12 Hz. Solitary pulses of 0.2 mJ energy and 23 ps

duration are extracted through two ML-103 shutters and a set of avalanche transistors acting as a generator of electric pulses for the test circuit. The laser beam is split by a set of semitransparent mirrors into several (four) partial ones impinging on a different optoelectronic gate each. These gates together with the tested field-effect transistor are placed in a common module with microstrip lines transmitting and strobing the electric input pulses. The transistor output pulses pass through a voltage converter to an Elektronika-60 microcomputer with a CAMAC interface for processing, the interface also controlling a stepper motor which varies the length of the optical delay line and thus times the strobing. The time resolution of transistor speed measurements has been established by analysis of the pulseform at the output of the first optoelectronic gate, a voltage rise time of 20 ps from 0.1 to 0.9 pulse amplitude being attainable with a 14 ps delay time between the last two gates. The instrument has been proved out in testing of a GaAs field-effect transistor for time characteristics of its output pulses. Figures 5; references 10: 1 Russian, 9 Western.

UDC 621.382.8.001.4

Acoustic Microtomography of Integrated Circuits
18600119c Moscow MIKROELEKTRONIKA
in Russian Vol 17 No 3, May-Jun 88 (manuscript
received 20 Mar 87) pp 231-236

[Article by K. A. Valiyev, A. V. Vinogradov, O. A. Zharov, V. Ye. Mukhin and V. N. Repin, Institute of Microelectronics, USSR Academy of Sciences]

[Abstract] The principle of a scanning tomographic acoustic microscope and the algorithm of imaging longitudinal sections of an object are shown to be applicable to microelectronic technology, namely to monitoring the internal structure of integrated-circuit chips. Such a chip is immersed in a fluid, distilled water, under the mirror surface of a plastic cover plate. A plane acoustic wave generated by a vibrating bottom plate impinges on the chip obliquely from underneath and also produces a ripple of the fluid surface under the cover plate, this ripple constituting the acoustic image of the chip. A scanning laser beam obliquely incident from above is reflected by that ripple with angle modulation and thus converts the acoustic image of the chip into an optical one, the ripple acting as an optical "knife edge" and the reflected light beam at continuously varying angle impinging on a photodiode which generates a corresponding electric signal for computer-aided reconstruction of the chip section. Various sections of the chip are imaged by rotation of the latter about its vertical axis. Use of a spherical acoustic wave is preferable, such waves being much more easily excited directly at the chip bottom surface without immersion fluid and various chip sections being imaged by moving the source of waves along the chip surface rather than by rotation of the chip. A spherical acoustic wave can be generated by a piezosemiconductor rod or by nonuniform thermoacoustic heating. In order to minimize the inherently fast attenuation of spherical acoustic waves along

their path as well as the nonuniformity of their intensity distribution in space, it is necessary to focus them on the chip or most desirably generate them inside the chip. The algorithm of imaging the chip structure is based on the Helmholtz equation in the Born approximation describing both incident and scattered acoustic fields in a weakly nonhomogeneous medium, with transverse wave ignored, and involves solution of this equation for the "object function" by numerical methods after direct and inverse Fourier transformations of the scattered field known from amplitude and phase measurements. The effectiveness of acoustic microtomography has been demonstrated on a micromillimeter chip with a transistor structure including an n^{+} -Si region and a p-Si region under a protective SiO_2 layer. Figures 6; references 11: 5 Russian, 6 Western.

UDC 621.382

Outlook for Development of Dynamic Memories With Very-Large-Scale Integration and Their Ultimate Attainable Design Characteristics
18600119d Moscow MIKROELEKTRONIKA
in Russian Vol 17 No 3, May-Jun 88 (manuscript
received 26 Feb 87) pp 237-243

[Article by V. A. Gergel, V. P. Mironov, V. V. Rakitin, Yu. I. Tishin and A. A. Chistilin]

[Abstract] The feasibility of developing dynamic direct-access memories with 16-64-256 MBit degrees of integration is examined theoretically from the standpoint of circuit design and chip topology layout, storage capacitors and discharge busbars presenting the major problem. Various techniques of memory cell miniaturization are described, taking into account established geometrical relations for all structural components and dimensional constraints on each. Superposition and merger of components, more efficacious isolation and interconnection of components, and refinement of the lithographic process are shown to make it practically feasible to stagewise reduce the surface area of a memory cell to $4.59 - 2.75 - 1.74 \text{ micron m}^2$. Feasible is evidently also very-large-scale integration of transistors and charge-coupled devices for amplification of the memory read-out current. Figures 5; references: 10 Western (2 in Russian translation).

UDC 621.382

Radiation-Induced Porosity and Microlithographic Characteristics of Polymethyl Methacrylate
18600119e Moscow MIKROELEKTRONIKA
in Russian Vol 17 No 3, May-Jun 88 (manuscript
received 6 Apr 87) pp 261-265

[Article by A. L. Bogdanov, K. A. Valiyev, L. V. Velikov and S. D. Dushenkov, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Formation of micropores in PMMA photoresist films during exposure to x-radiation was discovered in an experimental study, their characteristic dimensions as well as volume fraction having been subsequently estimated on the basis of gas-permeability measurements. A pressure drop of 20 Pa was maintained across

a 0.001 mm thick and 1 cm² large film without substrate during its exposure to x-radiation. Its gas-permeability above the diffusional threshold was found to increase with increasing radiation dose over the 20-100 mJ/cm² range of the latter, this increase being describable by a power-law relation with an exponent somewhat lower than 2. This trend is attributable to a build-up of film porosity, its geometrical and dimensional characteristics having been estimated statistically by the Monte Carlo method according to the theory of leakage and on the basis of two models regarding a photoresist film as a mixture of dielectric and conductor particles: all particles spherical in the first model, a conductor particle formed as a cubic lattice with resistive bonds. The presence of micropores in such a film was found to improve both its sensitivity and gamma. This effect was measured on 0.001 mm thick PMMA films, positive photoresists being exposed to x-radiation under templates with 0.0001 mm thick gold masking layers. The quality of drawings improved not only on the porous films but also on the heat-treated and thus initially nonporous ones, exposure to x-radiation having evidently made them porous. Figures 5; references 10: 4 Russian, 6 Western.

UDC 621.382.8

Feasibility of Dimensionalized Plasma Etching of Polysilicon Layers for Formation of Micrometer-Size Very-Large-Scale-Integration Components and Characteristics of This Process

18600119f Moscow MIKROELEKTRONIKA in Russian
Vol 17 No 3, May-Jun 88 (manuscript received
19 May 87) pp 270-277

[Article by G. V. Vasilyev, L. V. Dyachenko and V. Yu. Kireyev, Moscow Institute of Electronics Engineering]

[Abstract] Plasma etching of polysilicon layers is considered for miniaturization and very-large-scale integration of microelectronic devices such as dynamic direct-access

memories, the major problem being to ensure adequately high selectivity of the process and to minimize its anisotropy. Optimization of the process by combining ion-plasma etching and vacuum plasma etching is feasible, use of triode arrays and flexible diode arrays being very effective but such devices not yet being commercially available. Four modes of ion-plasma etching are therefore considered, with the etching rate differently governed in each: 1) etching rate governed by spontaneous chemical reactions alone and not at all by ion bombardment, 2) etching rate governed also by chemical reactions which ion bombardment stimulates; 3) etching rate governed principally by stimulated chemical reactions and thus by ion bombardment, in absence of spontaneous chemical reactions and with low rate of mechanical erosion caused by ion bombardment, 4) etching rate governed principally by mechanical erosion and thus by ion bombardment, in absence of spontaneous chemical reactions and with low rate of stimulated ones. The first mode represents vacuum-plasma etching and the fourth mode represents chemical ion-plasma etching, while the second mode represents a combination of both and the third modes combines chemical with mechanical ion-plasma etching. The results of an experimental comparative evaluation involving KDB-7.5 Si wafers 100 mm in diameter with (100) orientation, thermally preoxidized to a 100 nm thick SiO₂ layer, and use of a 9:1 SF₆:C₂Cl₃F₃ mixture as plasma-generating gas indicate the feasibility of plasma etching to meet the dimensional requirements of 1 M integration. The etching rate will depend on the process mode, with a gas pressure of 15-17 Pa and a gas flow rate of 33-40 cm³/min in a 250-300 W plasmotron. The lower pressure limit and the upper flow rate limit as well as the upper power limit represents technological constraints. All these process modes, including vacuum-plasma etching, must and can be optimized for maximum productivity. Figures 4; references 13: 6 Russian, 7 Western (1 in Russian translation).

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